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EDITORIAL

TOMATO CULTIVATION

IN this number appears the fourth and last part of an article on Tomato Cultivation in the Dry Zone of Ceylon, which started in the November, 1935 issue. The writer of the article calls attention to the growing interest in tomato cultivation in the dry zone areas of the Island and emphasises the high food value of the tomato owing to its richness in vitamin content, whether in the ripe, fresh, cooked or preserved fruit. He alludes to the good yields and return per acre which may be obtained with good and intensive cultivation, but issues a warning against overproduction unless wider markets can be secured. A good local market near a large town is essential, and the possibility of co-operative associations of tomato-growers is suggested for larger areas. More investigation is required on such problems as yield, varieties, systems of cultivation, planting seasons, etc., and the available information on these points is detailed in the various parts of the article, being derived mainly from published results of investigations in the United States of America. Some information of practical value has already been obtained by the writer of the article from the cultivation of a tomato crop at the Experiment Station, Anuradhapura, and further trials are to be made.

The tomato plant needs rather a warm climate with plenty of sun and a light rainfall of between 40 and 60 inches in the dry zone. These plants also require sheltered situations or the provision of wind belts, and moderate temperatures of 65° to 85° F., if they are to be successfully grown. As regards varieties,

the advantages and disadvantages of the main types, namely, flattened, flattened globular and round or globular, are reviewed, and the importance of uniformity in size and shape is stressed ; for this reason the round or globular type is preferred, as being more uniform. Passing on to soil conditions, it has been found that tomatoes do best on rich, sandy loams, well-drained, but at the same time capable of retaining sufficient moisture during drought. A suitable crop rotation for tomatoes is desirable, including a leguminous crop, but other solanaceous crops, such as chillies or tobacco, should not follow tomatoes on the same land owing to the risk of certain pests and diseases common to solanaceous plants. As regards seed production, it is better for the ordinary grower not to attempt to produce his own seed but to purchase it regularly from a reliable seed firm. Such seed, however, is usually imported from temperate climates, and further investigation is needed to produce varieties which are suited to tropical conditions.

The various cultural measures, such as preparation of nurseries, sowing, pricking out, preparation of the soil, manuring, planting out, pruning and training, etc., are explained in detail. Notes are also given on the changes that occur in the fruit during its growth and ripening, and advice on grading and packing is included. Mention is made of the yields which may be expected from good cultivation on a field scale, given favourable climatic conditions and freedom from serious pests and diseases, and an indication is given as to the costs of production per acre of tomatoes. The article concludes with brief notes on the more important diseases and pests which may affect the tomato plant, with suggestions for their prevention and cure.

TOMATO CULTIVATION IN THE DRY ZONE OF CEYLON—IV

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YIELDS

One of the most important factors determining the success of tomato cultivation is yield, which as previously shown is largely dependent on the cultural methods adopted by the grower. The weather conditions prevailing during the growth of the crop and the incidence of pests and diseases, which in the case of the tomato crop is particularly associated with unseasonable weather, also influence the yield to a considerable extent.

There is a wide variation in the recorded yields of tomatoes from different countries. Under field conditions yields vary from about 3 to 20 tons per acre in general, although according to Work (1926) as much as 35 tons per acre have been obtained in the U.S.A.

Mc Cue and Pelton (1913) state that in U.S.A. tomatoes when grown for canning purposes are not profitable under about 6 tons per acre, but Jones and Rosa (1928) record 4 tons as being the U.S.A. average. Pearson and Porter (1932), however, report 7 to 12 tons as being the usual yield. The yields of canning tomatoes need to be high, since the profits are otherwise small owing to the lower prices paid for the crop in comparison with market tomatoes.

Market tomatoes do not generally give as high a yield of salable fruit as in the case of tomatoes for canning and manufacture. Yields usually vary from about 3 to 6 tons per acre, but with intensive cultivation, pruning, training and closer spacing gross yields of 15 to 25 tons per acre have not been uncommon. At the Central Farm, Coimbatore, Raghavan (1933) states that the yields vary from 7 to 17 tons per acre, the lowest yield being 4·8 tons.

In Ceylon, the yields of tomatoes are generally between 2 to 3 tons per acre. This is low but the spacing has been comparatively wide, usually about 3 ft. apart. The yield per

plant is about 2 lb., although this could be increased with the application of manures and fertilisers and judicious irrigation during dry weather. In the Canaries, Holmes (1931) states that the yield per plant varies from 2 to 6 lb. depending on the type of land used and the intensiveness of cultivation. The spacing there is fairly close, about 9,000 to 13,500 plants being grown per acre. At 3 ×1 ft. there are 14,520 plants per acre and hence if each plant in Ceylon gives a minimum yield of 2 lb. at this spacing the total yield per acre can be very greatly increased. Factors which tend to reduce yields are unfavourable weather conditions and pests and diseases as stated above. The effect of the former can be lessened to a limited extent by cultural devices and the latter by preventive and control methods against the particular pests and diseases attacking the crop, but these may not be entirely effective and during certain unfavourable seasons the yields may be low. But, generally, the yields of tomatoes in Ceylon can be largely increased particularly by closer planting, but also by the intensive methods of culture previously described.

COST OF PRODUCTION

The cost of growing tomatoes under field conditions largely depends on the method of cultivation and labour rates. It has been previously stated that for high yields intensive methods must be practised, but consideration should be paid to the cost of labour and materials in any locality before deciding on the particular method to be adopted. In view of the variation in labour rates paid in different localities figures of cost alone are not a sufficient guide unless the work required for each operation is recorded in units of days per head, *e.g.* men days. These units vary within certain limits with the efficiency of the labour and the implements used for each operation and so any cost figures that are published on this basis are only an approximation. The cost of materials required also varies considerably with the locality, *e.g.* in the case of stakes and scantlings which may in certain areas be prohibitive in cost for trellising tomatoes.

Nevertheless, as a general guide the cost of production of tomatoes per acre in the dry zone is given here, based on average labour rates in the area. The method employed in growing the crop is staking and pruning to a single stem, the planting distance being 9,680 plants per acre.

ESTIMATED COST OF PRODUCTION PER ACRE OF TOMATOES

		Men days @ -/60Cts.	Women days @ -/35Cts.	Bullocks @ Re. 1/- perpair	Rs. Cts.
1.	Seed and Nurseries ..	6	5	—	15·00
2.	Ploughing	2	—	2	3·20
3.	Harrowing	½	—	½	0·80
4.	Manure and application 12 tons at Rs. 3·00	4	—	—	38·40
5.	Harrowing after Manuring ..	½	—	½	0·80
6.	Ridging (plough and hoes) ..	14	6	2	12·50
7.	Fertilisers	—	—	—	25·00
8.	Planting out	2	35	—	13·45
9.	Intercultivation, earthing up and application of fertilisers	25	50	3	35·50
10.	Pruning, Staking and Tying ..	40	60	—	45·00
11.	Irrigation	—	—	—	60·00
12.	Picking and Transporting ..	10	25	—	14·75
13.	Grading and Marketing (including freight)	—	30	—	135·60
		104	211	8	400·00

Yield per acre (minimum)	6 tons	
Yield of graded fruits (85% of total) ..	5·1 tons	
Quantity of marketable fruits (allowing 15% for damage, etc. in transit) ..	4·3 tons	
		= 8,632 lb.

Estimated Value—1st Grade	6% – 518 lb.	@ 15 Cts.	77·70
2nd Grade	48% – 4,143 lb.	@ 10 Cts.	414·30
3rd Grade	31% – 2,676 lb.	@ 05 Cts.	133·80
			625·80

The prices offered to the grower will vary considerably according to the season in which the crop is produced, but for good quality fruits prices of the 1st and 2nd grade may vary between 10 to 30 cents per lb.

In U.S.A., Carncross and Nissley (1932) carried out a survey of tomato farms in New Jersey and report an average cost of $107·15 per acre with variations from $83·93 to $156·01 per acre, while Norton (1922) records an average of $164·59 for New York farms, of which $59·20 are used in marketing costs. Raghavan (1933) gives the cost of cultivation at the Central Farm, Coimbatore, as not exceeding Rs. 160·00 per

acre, including the cost of irrigation, but the labour rates there are low even in comparison with Ceylon.

When the yields are high due to better methods of cultivation the cost per ton of the crop is decreased even though the total expenditure is higher. Norton found the cost of production varied from $43·56 per ton where the yield was below 5 tons per acre to $10·15 where it was over 15 tons. The tomato grower should, therefore, aim at intensive production of his crop in order that his net returns should be large.

SEED GROWING

Although it is now, generally, advisable for tomato growers to purchase their seed from reliable seedsmen it may be necessary for a grower to raise his own seed on occasions. It is also possible for a careful grower under suitable conditions for the production of seed, to develop an improved acclimatised strain by selection.

In selection for new strains, the grower should mark particular plants which show any outstandingly desirable characters for propagation, but where seed of an already established strain or variety is to be raised, plants which are not true should be removed. In the former instance, individual plants should be selected for such characters as early maturing, bearing capacity, size, shape and quality of fruit. It is of course essential that the plants should be vigorous and healthy.

For seed purposes only fully ripe fruits should be picked, as immature or green fruits give rise to seed which produces plants which are poorer in yield and quality. The fruits should also be large and regular in shape and it is advisable to pick the fruits for seed purposes when the plants are in the best period of their fruiting.

As tomatoes are liable to a certain amount of crossing, even though this may not be very great, it is best that each variety be grown as widely separated from another as possible. In the case of selection for a new strain the seed from a single selected plant should be sown separately and multiplied up the following season. The selection of individual plants should, however, be continued for sometime until the plants show no signs of degeneration of the new characters of the selected strain.

In the preparation of seed, the ripe fruits should be pulped by pounding or by passing them through a grinder. The resulting gelatinous mass should be allowed to stand for a period of 1 to 3 days for fermentation. Water should then be added and after stirring, the skin and pulp with any poorly developed seed which floats on top can be separated from the plump seeds

which sink to the bottom. Water should again be added and the process repeated several times until the seeds are thoroughly cleaned. They should then be removed mixed with fine wood ashes and dried in the sun as quickly as possible. When quite dry the excess ash should be removed by winnowing and the seeds stored in airtight vessels.

DISEASES

Some of the more serious diseases of tomatoes are caused by fungi or bacteria which are carried over in the seed or live in the soil of seed beds. It is for this reason that precautions should be taken to sterilise the soil in seed beds where tomatoes or other solanaceous seedlings like tobacco have been grown often. The seed may be effectively sterilised by soaking it in a solution of 2 oz. of copper sulphate dissolved in 1 gallon of water. It should be tied up loosely in a cheese cloth bag and soaked for 1 to 2 hours in the copper sulphate solution after which it may be dried or sown immediately.

(A) "DAMPING-OFF" (PYTHIUM, RHIZOCTONIA, ETC.)

This disease, which is attributed to the attacks of various fungi, occurs in the nurseries. The young seedlings are chiefly attacked, the first symptom being a slight wilting of the cotyledons at their tips and then the stems become water-sodden just above the surface of the soil. Later a white or grey mycelium becomes evident. Damping-off is favoured by humid conditions and inadequate ventilation. The disease is prevented earlier by sterilisation of the soil and seed. Watering should be reduced and ventilation increased. A layer of sand about $\frac{1}{4}''$ deep should be sprinkled over the surface, as it prevents the surface soil remaining damp. This disease is, however, not very serious in the dry zone.

(B) WILT DISEASES

The class of diseases grouped together as wilt are, in general, the most serious of those attacking tomatoes in the field. The three main wilt diseases of tomatoes in the tropics are given below.

(1) *Fusarium wilt.*—This disease is caused by the fungus *Fusarium lycopersici* (Sacc.) and is one of the commonest of the wilt diseases. Infected plants turn yellow and wilt and later die. One of the chief characteristics of the disease is the presence of a brown discoloration of the woody tissues of the stem just below the greyish green outer skin. As soon as a diseased plant is observed it should be immediately removed and destroyed. A crop rotation should be practised, and, as far as possible, solanaceous plants should be avoided for 2 to 3

years. There are varieties of tomatoes that have been bred for resistance to wilt, such as Marglobe and Norton in the U.S.A. But it is possible that owing to the existence of a number of strains of the fungus differing in virulence, a variety known to be resistant in one country may not prove resistant in another.

As a precaution against wilt, the seed and nursery should be sterilised.

(2) *Bacterial wilt.*—This is a bacterial disease caused by *Bacterium solanacearum* (E.F. Smith). Prior to wilting the plants frequently assume a stunted appearance. Wilting takes place rather rapidly and completely without a preliminary yellowing and the plants soon die. If the stems are cut across the tissues are seen to be brown and a creamy bacterial discharge exudes from the cut vessels.

The same measures advocated against Fusarium wilt, with the exception of wilt resistant varieties which are not known for this disease, may be adopted.

(3) *Sclerotium wilt.*—The fungus *Sclerotium rolfsii* (Sacc.) has been found responsible for this disease which is somewhat common in the dry zone. The leaves of affected plants wilt with no preliminary discoloration. The fungus generally attacks the plant near the ground level where the stem is usually killed. Just above ground level a white feathery mycelium may be seen growing around the stem and numerous sclerotia of about the size of a mustard seed may be seen among the mycelium on the stem as well as the roots.

Infected plants should be removed and burnt. Attention should be paid to cultural methods. The soil should be kept well-drained and in a good state of tilth.

(C) PHYSIOLOGICAL DISEASES

(1) *Leaf Curl.*—This is a little understood disease in which the leaves of attacked plants show a pronounced curling and wrinkling. Fruiting becomes restricted and the plants remain stunted.

(2) *Blossom end rot.*—This disease is common wherever tomatoes are grown. It is a non-infectious disease which is connected with environmental conditions—moisture and temperature. Small brown spots which later enlarge in size form at the blossom end of the fruit rendering it usually flattened at this end.

It is considered that when the soil moisture is suddenly diminished or there is an abrupt rise in temperature more moisture is lost from the plant than can be taken through the roots and moisture from the fruits is withdrawn at the end

furthest away from the stem. The disease seldom appears where the amount of soil moisture is adequate or gradually diminishes towards the end of the growing season.

When conditions become suddenly arid or hot irrigation of the plants, if possible, should be carried out.

(3) *Sun Scald.*—The presence of patches on the surface of the fruit in which the skin appears blistered characterises this condition.

(4) *Cracking.*—Fruits in certain seasons show marked cracking of the skin. The cracks develop both radially and concentrically from the stem end. The radial cracks penetrate slightly below the skin into the flesh while those that are concentric are only confined to the skin.

(D) VIRUS DISEASES

There are several types of virus diseases of tomatoes that have been described by plant pathologists. They are caused by infective agents which are too small even to be seen by the best microscope. These diseases are transmitted by aphides and other sucking insects.

The commonest virus disease is Mosaic which produces a green and yellow or light green mottling of the foliage. The plants may be distorted by crinkling, dwarfing, etc. The flowers become distorted and "setting" of the fruits is prevented. When the disease once appears in the field, it is difficult to control because just a few aphides are sufficient to carry the infection. It is important that all weeds which are susceptible to mosaic should be early removed from the vicinity of the field. Mosaic infected plants should not be pruned or handled. When, however, only a few plants are infected they should be removed at once and destroyed taking care to disinfect one's hands before handling uninfected plants immediately after removing the mosaic plants.

(E) EELWORM

The eelworm *Heterodera marioni* is responsible for a serious infection of the roots and is known as root-knot. The roots of affected plants develop gall-like swellings and the plants become stunted, turn yellow and finally die. Within the tissues of the gall-like swellings, the eelworm will be found in all stages of development.

Rotation of crops for 2 to 3 years should be carried out to starve the nematode out from infected soil and only eelworm-resistant crops should be grown during this period.

For further information on any of the above diseases application should be made to the Mycologist, Peradeniya.

PESTS

The following brief notes are given on some of the commoner pests found attacking tomatoes in Ceylon.

(A) FLEA-BEETLES

Damage by flea-beetles results in a pitted appearance of the leaves of young plants in the nurseries. This causes considerable weakening of the young plants.

(B) GRASSHOPPERS

Various species of grasshoppers have been responsible in the dry zone for attacking young plants in the nurseries. Lighted fires at night in the neighbourhood of the nurseries are sometimes effective in trapping the insects.

(C) CUTWORMS

These caterpillars, which are usually active at night, cut the young plants at ground level. A poisoned bait may be employed, such as Paris Green $\frac{1}{4}$ lb., bran or rice dust 5 lb., jaggery 1 lb., and water 7 pints. These ingredients are mixed to form a stiff marsh, and small lumps are put out near the plants overnight.

(D) HORNWORMS (PROTOPARCE SP.)

These are large green caterpillars with white stripes extending diagonally across the body and a curved horn on the rear. They rapidly strip off the foliage leaving the plants quite bare. The plants may be sprayed with lead arsenate at the rate of 1 oz. per 2 gallons of water, but hand picking should also be resorted to whenever possible. The lead arsenate spray is also useful against all leaf-eating insects, such as flea-beetles, etc.

(E) FRUIT-BORERS (HELIOTHIS OBSOLETA AND PRODENIA LITURA)

These are the most serious pests of tomatoes and are very prevalent when the crop matures in wet weather. The young caterpillars at first feed on the leaves and then burrow into the fruit generally at the calyx and rendering such fruit completely unsaleable. Spraying with lead arsenate is partially effective, but it should not be done after the fruits are half-grown. All damaged fruits should be picked and fed to poultry. The soil between the rows of plants should also be hoed to destroy the pupae.

Further information on insect pests of tomato can be obtained on application to the Entomologist, Peradeniya.

LITERATURE

BAKER, W. B. Growing Tomatoes in Kansas. Kansas Agric. Expt. Station, Circular No. 172, 1933.

BEATTIE, W. R. Tomatoes as a Truck Crop. U.S.A. Dept. Agric., Farmers' Bulletin No. 1338, 1923.

BEWLAY, W. F. Tomatoes: Cultivation, Diseases and Pests. Ministry of Agriculture and Fisheries, England, Bulletin No. 77, 1935.

CARNCROSS, J. W. AND NISSLEY, C. H. - New Jersey Canhouse Tomato Production. New Jersey Agric. Expt. Station, Extension Bulletin No. 96, 1932.

CARVER, G. W. How to Grow the Tomato and 115 Ways to Prepare it for the Table. Tuskigee Institute, Bulletin No. 36, 1918.

CORBET, S. — Biological Progress in Tropical Soils. Heffer, Cambridge, 1935.

DE BAUN, R. W. - Early Tomato Growing in New Jersey. New Jersey Agric. Expt. Station, Circular No. 103, 1922.

FRIEND, W. H. Tomato Varieties and Fertilisers for the Lower Grande Valley. Texas Agric. Expt. Station, Bulletin No. 438, 1933.

HOLMES, E. - Tomatoes in the Canaries. *Trop. Agriculture*, Trinidad, Vol. VIII, 1931.

JONES, H. A. AND ROSA, J. T. — Truck Crop Plants. McGraw-Hill, New York, 1928.

KRAUS, E. J. AND KRAYBILL, H. R. - Vegetation and Reproduction with Special Reference to the Tomato — Oregon Agric. Expt. Station, Bulletin No. 149, 1918.

LEWIS, E. E. Tomato Growing in Michigan. Michigan Agric. Coll. Expt. Station, Special Bulletin No. 131, 1924.

LLOYD, J. W. AND BROOKS, I. S. — Growing Tomatoes for Early Market. Illinois Agric. Expt. Station, Bulletin No. 144, 1910.

MACDONALD, J. A. — A Sensitive Pot Test for Phosphate Deficiency in Soils. *Trop. Agriculture*, Vol. X, No. 4, 1933.

MC CUE, C. A. AND PELTON, W. C. — Tomatoes for the Canning Factory Delawar Agric. College Expt. Station, Bulletin No. 101, 1913.

NIGHTINGALE, G. T. — Effects of Temperature on Metabolism in Tomato. Bot. Gaz., Vol. XCVI, 1933.

NORTON, E. J. An Economic Study of the Production of Canning Crops in New York. Cornell Univ. Expt. Station, Bulletin No. 412, 1922.

OLNEY, A. G. Some Experiments with Tomatoes. Kentucky Agric. Expt. Station, Bulletin No. 218, 1918.

PATERSON, D. D. — Tomato Experiments. *Trop. Agriculture*, Vol. VIII, No. 9, 1931.

PAUL, W. R. C. — A Varietal and Spacing Trial of Tomatoes. Unpublished Dissertation, Library, Imperial College of Trop. Agric., Trinidad, 1934.

PEARSON, D. H. AND PORTER, D. R. — Tomato Production in California. Circular No. 66, 1932.

PFEIFFER, N. E. — Microchemical and Morphological Studies of the Effect of Light on Plants. Bot. Gaz., 81, 1926.

QUINN, G. The Production of Early Out-door Tomatoes. Dept. Agric., S. Australia, Bulletin No. 196.

RAGHAVAN, K. K.—Tomato or Love Apple. *Madras Agric. Jl.*, Vol. XXI, 1933.

ROSA, J. T.—Better Methods of Tomato Production. Missouri Agric. Expt. Station, Bulletin No. 194, 1922.

SANDY, C. E.—The Process of Ripening in the Tomato considered especially from the Commercial Standpoint. U.S.A. Dept. Agric., Bulletin No. 859, 1920.

SENARATNE, N. AND SENATHIRAJAH, N.—Tomato Cultivation. Dept. Agric., Ceylon, Leaflet No. 49.

STUCKEY, H. P.—Tomatoes. Georgia Agric. Expt. Station, Bulletin No. 112, 1915.

THOMPSON, H. C.—Experimental Studies of Certain Vegetable Crops. Cornell Univ. Expt. Station, Memoir No. 107, 1927.

THOMPSON, H. C.—Vegetable Crops, New York, 1931.

WARDLAW, C. W. AND MCGUIRE, L. P.—The Storage of tropically grown Tomatoes. Empire Marketing Board Report, No. 59, 1932.

West Indian and Inter-Colonial Fruit and Vegetable Conference Report, Recommendations and Proceedings, Jamaica.

WORK, P.—Tomato Production. New York, 1926.

WORK, P. Descriptions of Types of Principal American Varieties of Tomatoes. U.S.A. Dept. Agric. Misc. Public. No. 160, 1933.

FRUIT CULTIVATION AND PRODUCTION

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DURING the past decade enormous strides have been made in many countries in respect to fruit production and export.

In Ceylon it has yet to attain any reasonable dimensions and the small amount of fruit produced in this Island in proportion to what might and should be produced is most depressing in view of the many advantages of climate, soil, varying elevations and cheap labour that we have in comparison to many other tropical and sub-tropical countries.

Such a state of affairs can however be improved upon and a beginning has already been made, though admittedly a very small one, and the lines on which this much hoped for progress can follow will be dealt with in this paper.

In the wider and world view it should be realised that the expansion in fruit production and correspondingly in the consumption of fruit throughout the world has, within the past ten years, and despite the world depression, exceeded enormously any previous decade, both in domestic consumption and in export.

On the one hand we find the opening of new areas, the improvement in cultivation, the more efficient handling and marketing, together with extensive publicity campaigns have, in the aggregate, enabled producers to market both larger crops and better quality fruits. On the other hand, the principle that the supply creates the demand, together with modern theories of nutrition in the vitamin values of certain fruits and a universal recommendation to eat more fruit stimulated by medical journals, by the daily press, and by food advertisements, undoubtedly accounts for the greater part of the present world increase in fruit consumption.

There is ample evidence of the pronounced improvement in human health brought about mainly by means of this increased consumption of fresh fruits, and of fresh vegetables, and there is little doubt that from a health point of view money spent on the purchase of fresh fruits and vegetables is money well spent indeed, and it can be assumed further that the

association of the problems of fruit cultivation and of health would present a very satisfactory line of future advance for Ceylon.

Before getting down to our local fruits and how to grow these it would be well to review as briefly as we can the progress in fruit growing of countries similarly situated, but outside Ceylon, as a guide to what might, or might not, be within our range of possibilities in the way of fruit production. It is essential in the space at my disposal to limit this article to tree fruits, but in passing a few notes might be given regarding other fruits which are a considerable source of revenue to other tropical countries.

PINEAPPLE

A recent publication by the Imperial Economic Committee gives us some interesting data. In pineapple production America and Hawaii provide the bulk, but Malaya comes next and has made great strides. In Formosa too pineapple production is assuming considerable proportions, but Malaya's exports amounted in 1934 to over 2½ million cases of canned pineapple, the greater portion of which is shipped to Great Britain.

There are unfortunately no accurate statistics as to local production of the various fruits grown here to give us any guide, but we all know that the pineapple grows well in certain parts of the Island. Is it possible for Ceylon to get a footing in the export trade in respect to this particular fruit ? At the moment it seems very doubtful, as the countries participating have the great advantage of being already in it, the enterprise is worked on most up-to-date lines and is well established. Further, Ceylon's deficiency of tin for can making creates one of the largest drawbacks, as Malaya, for instance, produces not only an excellent fruit but the tin also and the latter advantage has no doubt been the main contributing factor in Malaya's progress in pineapple export.

To make any strides at all for growing in bulk and the commercialising of any fruit, capital and organisation are very essential factors, especially when the exporting stage is reached. In 1933 a Pineapple Packers' Association was formed in Malaya which provided for a pool with the object of preventing violent fluctuations in the price of the fresh fruit, controlling supplies and economising in overhead charges by closing certain factories where necessary and paying compensation to the owners. The money required to carry out this scheme was obtained by a cess of 25 cents per case of canned pineapple exported. The object of this was not so much to reduce potential supplies

as to cope efficiently with the substantial increase in acreage and increasing output of fruit that has occurred of late.

There is of course a large acreage in pineapples in Malaya, but only about one-third of this acreage is cultivated as a sole crop the remaining two-thirds of pineapples are grown as a catch crop, chiefly on rubber plantations. Ordinances also are in force to exercise close control over production, for the improvement of the product for export, for factory registration, grading, certification, and marking. The Pineapple Experiment Station in Singapore is working on lines designed to improve cultivation and pineapple strains, to evolve a pineapple possessing all the desirable characteristics of the local canning variety and the eliminating of its disadvantages. The variety used for canning is presumably the Smooth Cayenne of which our local Kew pine seems to be a variety. The above indicates I think some of the preliminaries necessary to a successful export trade in this fruit.

CEYLON'S PRODUCTION AND CONSUMPTION

This brings me to a point I wish to emphasise very forcibly with all fruits that can be grown here, and this is that few at this stage are likely to be a source of profit as an exported crop, though some types of citrus would be an exception, and it is on improving the quality and enlarging the demand for home consumption that our attention should be first concentrated. At the moment little fruit of any consequence or on any scale is exported from Ceylon, but on the other hand we import a certain amount and the imports are increasing each year. In citrus imports alone in 1930 we imported 5,948 cases, and according to data supplied by the Fumigation Officer stationed at the Customs we imported in 1934, some 10,529 cases, or practically doubled our imports. In detail these imports consisted of 7,500 cases of oranges and mandarins, 1,680 cases of grapefruit, 109 cases of lemons and 1,230 bags of limes, the latter from India. That we should import limes is a remarkable instance in our backwardness in fruit production, since this particular fruit can be grown well in so many localities and moreover from seedling trees. There is no reason why we should not, by increasing local production of citrus, supply not only sufficient to eliminate these imports, (which are after all very small in ratio to population), but create a local demand that would assimilate a vastly greater amount. The imported fruit is undoubtedly retailed at a very high price and this price factor is in itself a serious limit to any considerable consumption.

At the moment Ceylon's home production is amazingly small, for fruit orchards as such do not appear to exist and it

is doubtful if a dozen tree fruit orchards in the whole Island of over 5 acres each could be found. It is apparent from this and from the import figures that fruit does not in Ceylon form nearly the percentage in diet that it does in practically all other countries. If emphasis or an illustration is needed on this point it can be stated that Great Britain imports and consumes in citrus alone, over ½ million tons of fruit which in ratio to population works out at 25 lb. per head. The relative purchasing power of the unit of population here has to be considered, but on the same consumption figures we in Ceylon would need 55,000 tons of citrus to meet the demand, or in other words, at 3 tons to the acre some 18,000 acres would be required to produce the crop.

PLANTAINS

With regard to plantains or bananas, Ceylon produces quite a fair quantity which are entirely consumed locally. Honduras, Jamaica and the Canary Isles are the chief exporting countries, whilst Brazil, Cuba and Formosa are increasing their production of this fruit. It represents in fact about 55 per cent. of Jamaica's total exports and trade and, though this has of late years temporarily declined owing to serious hurricane damage, the 1934 exports are again on the increase representing 322,000 tons or somewhere about 16 million bunches.

The chief market for the Jamaica exports is Great Britain, but all importing countries appear to be increasing their demands for this fruit. The 16 million bunches exported from Jamaica must, at 400 bunches to the acre represent some 4,000 acres of this fruit. The Gros Michel is I believe the variety mostly grown, a variety not unlike our Koli-kuttu. Transport under suitable cold storage conditions would probably be Ceylon's greatest difficulty in any export trade with this fruit, but again increased home consumption and supplies to boats calling at Colombo would call for a considerable acreage.

PAPAW

Papaw might also be mentioned owing to its nutritive value in a local diet and for papain production.

This fruit appears to have been in the Island for several centuries now and there is not a great deal to add to our present knowledge. We have in Ceylon probably the best varieties in cultivation for size and flavour and though it cannot be classed as a fruit for other than local consumption until more is known of the export of these soft fruits, it can, even at that, be grown in much larger proportions than at present. It is one of the easiest of fruits to grow and possesses most refresh-

ing, agreeable and digestive properties, and is essentially a fruit for the villager.

As most of you know, perhaps, the fruit is raised purely from seed and attains the fruiting age at from 10 to 12 months the shape of the fruit varying according to the variety from round to oval or oblong. The oblong fruits are generally considered the best for the table and these reach the dimensions of 14 or 15 inches in length in a well grown fruit.

It is always wise to select seed from a well grown fruit of good flavour for seedling purposes, in spite of the fact that the tree is dioecious and cross pollination is most general. It is a general assumption that a normal batch of seedlings invariably yield more male, which, of course, bear no fruit, than female trees. This is not so, however, and the average in general is 50 to 50.

In this respect experiments on the improvement of papain content of papaws by the Economic Botanist at Peradeniya in a plot of 126 holes, 4 plants to each hole, showed the plants to breed out as follows, the male and hermaphrodite plants being combined under the heading of males.

4 males per hole	8	holes
3 males and 1 female per hole ..	41	
2 males and 2 females per hole ..	43	,,
1 male and 3 females per hole ..	26	,,
4 females per hole	8	,,
	126	,,

Of the 126 holes containing 504 plants therefore 265 were male or hermaphrodite and 239 females and in view of the fact that a percentage of hermaphrodites give good fruits the 50 to 50 percentage contention seems well supported.

Apart from the edible fruit-value of the tree is the production of papain the demand for which continues at fairly remunerative prices, though less in value than formerly. Like the Chickle gum later referred to it is used in the preparation of chewing gum as well as in medicine and in the preparation of certain foods, and is exported from Ceylon mostly to America.

The fruit, when fully grown and about 3 months old, is tapped or incised every 4 or 5 days by sharpened bamboo sections in the form of a knife, and the milky latex which exudes is caught in containers. This soon coagulates and forms a white curd with a somewhat pungent smell. It is quickly dried, in the open in dry weather, though not in the sun or the product becomes darkened and its value is reduced.

The yield in papain per tree is estimated at from ¼ lb. to ½ lb. and 175 lb. to the acre is considered a good yield the cost of production amounting on the average to about Rs. 3.00 per lb. and the return on exported papain working out on the average of between Rs. 5.00 to Rs. 6.00 per lb.

Ceylon appears to hold its own in competition with Jamaica in this respect, but the market is I believe a limited one and the question whether any large extension in the cultivation of the fruit for this purpose is advisable needs to be further studied. Full particulars of the cultivation and preparation of this product can be found in Leaflet No. 44 issued by the Department some years ago, and the present work on the improvement both of quantity and quality of papain should benefit this industry by reducing the costs of production here.

Let us now confine our immediate attention to the cultivation aspect of those tree fruits which can be considered best suited to our local conditions and of considered merit as a crop for home consumption and where possible, for export purposes also.

Given the necessary capital and enterprise the main factors are, selection of the best type possible, selection of a site and environment suited to the type of fruit it is decided to grow, and thirdly nothing short of the best cultivation methods possible.

MANGO

Taking the mango as our first subject, all here know and appreciate this fruit but all also realise the difficulty in obtaining really first class fruit. The season is short, the supply is limited and the fruits invariably suffer from being picked, while too unripe. Much can be remedied, however, if it is recognised that the mango is best cultivated where a pronounced dry season is experienced, for the tree requires the stimulus of a dry season at the time of flowering and setting of fruits.

Full details of the cultivation of this fruit is given in *The Tropical Agriculturist* for April, 1931, supplemented later by a short article in 1933 under "Cultivation of Fruit" Group II, for dry and semi-dry zones, and available in leaflet form. Though varieties of the mango do fruit in the wet zones it is in the dry and semi-dry zones that this tree will flourish and the Northern Province and similar localities of the Island are well suited to its cultivation. In the many requirements of cultivation the above articles should be studied and I would here add that there are now well over a dozen different varieties being propagated which are of exceptional merit. The Agricultural Officer in charge of the fruit experiments and produc-

tion in the Northern Province is of opinion that the mango there is exceptional in that unlike most other fruits it can be grown in the dry zone without irrigation facilities after its third year, (the period necessary for the plant to become established and form a sufficient root system), and that this point when fully realised is the key-note to success in the cultivation of the mango in Jaffna and neighbouring parts. The best varieties as grown at the Farm School are the Villard and Dilpassand, though there are other excellent varieties also, particularly the Alphonso and Jaffna varieties and with mangoes, at least, the calcareous red soils of Jaffna produce a better flavoured fruit than those on the grey and sandy soils.

The methods of propagation applicable to the mango have latterly been improved upon, the cleft or wedge-grafting now superseding the bud-grafting previously advocated, since the former method seems to induce a better shaped tree, the union is more satisfactory and subsequent growth is more rapid. The root-stocks on which the scion is budded include the common Indian mango, or Amba, and the indigenous mango or Etamba, The comparative value of these root-stocks appears so far to be about the same, but a larger percentage of success in buddings is usually obtained from the Indian root-stock than from the local root-stock.

Experiments here and in Java in the use of the cashew nut and species of the hog plum have not been successful and at the present stage of our knolwedge it seems doubtful if the common Indian mango and the local Etamba can be improved upon as a root-stock.

The budded plant is fairly free from pests and diseases, but two weevil pests are frequently troublesome, the leaf-eating weevil, and the flea weevil. The former cuts through the young leaves, thereby mutilating the plant to a harmful degree and often defoliating the plant of whole flushes of new growth. The latter also attack the young leaf-growth, and the leaves are badly spotted, curl up, and become distorted. Both of these pests are fully described, with coloured plates, in *The Tropical Agriculturist* for August, 1934, and the remedy in each case is to spray the leaves with lead arsenate at the rate of 1 oz. to 2 gallons of water. The spray is best supplied as soon as the young leaves and blossoms appear.

That successful orchards, given enterprise and sufficient capital, can be opened up is in little doubt, and that object should be mostly to supply the home market, since it is doubtful if any export of this fruit can attain any reasonable dimensions at present.

The latter statement is my own opinion based on the fact that I have not yet been fortunate enough on my periods of home leave to purchase a fruit in any way approaching the flavour and freshness of that obtained locally, though one pays the equivalent of 50 cents and upwards per fruit. It seems to me also that until a mango fruit can be produced with the ratio of stone or seed reduced and entirely free from fibres, as with the freestone peach for instance, thereby allowing the seed to be more easily separated from the edible portion and eaten in a more elegant manner, it cannot well compete with other fruits in the European and American markets, such as apples, pears, oranges, or soft fruits as apricots, nectarines peaches, plums and so on.

This need not, however, cause us any concern at the present moment for it is the home market that needs catering for and this alone could, if properly organised, absorb the product of a fairly considerable area. With a population, as in Ceylon, of 5 million, a consumption of one mango per head per year would obviously involve the production of that number of fruits. At 10,000 fruits annually per acre, *i.e.* an average of 200 fruits per tree at 50 trees to the acre an area of 500 acres of mangoes would be needed. Multiply this to 10 fruits per head per year and some idea of the possibilities are seen. There is, of course, the present production of mangoes to be set off against these figures and with due respect to present growers it is a very poor type of mango one mostly finds on the market and chiefly in one limited and very short season during which the market is entirely glutted. A further point, therefore, in addition to any up to date cultivation on orchard lines and the selection of a more superior type of fruit, is to select and grow varieties with a range of season of maturity. There are such, and orchard areas in different localities will assist this purpose, for Uva and the Eastern province could produce the same variety of fruit as Jaffna, but by reason of their local conditions at a season varying considerably from the latter.

One point might here be made which applies to most fruits and it was forcibly commented on by the late Director of Agriculture in a recent Annual Report. He states with ample data at his disposal "that much of the failure to establish fruit industries here is due to the non-realisation of the facts that other countries would not be satisfied with the type of fruit that is acceptable here and is for sale in the markets of our towns; that fruits must be produced by organised business methods to an extent that makes grading and the production over and over again of a uniform sample, possible propositions." This is all too true and applies particularly to citrus, but also to mangoes and other fruits. Before leaving these notes on

mangoes I would again ask you to refer to the articles already published on this subject by the Department of Agriculture and in which are embodied the main principles of cultivation and upkeep.

MANGOSTEEN

Passing now to the mangosteen, this is a fruit requiring a totally different environment and conditions to that of the mango, and is specially adapted to a hot and humid climate from sea level to an elevation of 1,800 to 2,000 feet or so. Very favourable localities are those of the low-country districts of Colombo, Kalutara, Galle, Moratuwa and inland as far as Mirigama and Polgahawela, whilst in Kadugannawa and Kandy exceptionally fine fruits can be obtained if the trees are well cultivated. So far as is known, the tree is not cultivated on any large scale but mostly in small groups or single specimens and is moreover restricted to the Eastern tropics.

This may be accounted for by the great difficulty experienced in successfully raising the young plants and in getting these established, as they are extremely delicate.

Under the best conditions a period of 7 years would elapse before the first fruits are obtained from seedling trees, and often it takes from 8 to 10 years. This long wait for returns has no doubt also militated against any considerable plantings of this tree, particularly on orchard lines in commercial proportions. The seed breeds fairly true to type, but an earlier fruiting period is much desired. To assist this, gooteeing of the branches is sometimes the means employed, though not very successfully, and grafting on to own seedlings has been undertaken, with more success.

Attempts to find a root-stock of more robust growth and earlier fruiting characters than the seedling have not yet proved successful, though the Goraka, the Kanagoraka and the Cochin Goraka have all been used for this purpose. The grafting itself is fairly successful, but no growth of any vigour is made subsequently, these root-stocks being apparently incompatible to the scion and no improvement on the own seedling stock. Since, however, grafting in some form is called for, if only for the maintenance by this means of superior strains of fruit, it would at the present stage of our knowledge be advisable to use only its own seedlings as root-stock on which to graft sections of any known high yielding tree or of one with any particularly desirable quality it is wished to perpetuate such as, extra sweetness, comparative seedlessness, or thinness of shell.

The method when grafting should be as for the mango, the wedge or cleft-graft, and it can be undertaken on 3 to 4 year

old seedlings or on younger ones if they are well grown and thick enough, or left till the plant attains several feet in height. In both cases very successful results have been obtained and instances are to be seen among a very fine group of these trees at the Orchard at Halloluwa, Kandy, the result of much enterprise and care and in which high yielding trees of recorded yield value are kept. When good sized and older seedlings are to be grafted the terminal centre shoot should be operated on, retaining the side shoots of the seedling to counterbalance any check to the plant's growth. As the tree ages these lower side branches fall away and any that do not so perish could be removed, so that the tree-head from the fruiting stage onward is composed of the scion only.

The mangosteen favours a sheltered situation rather than an exposed windy hillside and does best in a valley protected by higher land all round. It is not known for certain, but it is generally believed that a high water table affords earlier maturing than otherwise. The mangosteen is a weak rooted tree and though the lateral feeding roots appear to progress and act in a normal manner there are really very few of them on the surface and it seems to be necessary for the main tap root to penetrate the permanently moist sub-soil layers. Further details on soils, etc., were available in the fruit articles referred to, but a very important point to bear in mind is that with mangosteens the soil should never be allowed to dry out and layers of coconut husks are recommended for a mulch and around all trees during dry periods.

In the past year or so the subject of the export of this fruit has been frequently raised both in the newspapers and in more technical journals and I have been very fortunate in having been able to discuss the matter with a grower who has carried out experiments in this respect for several years, as to type of fruit sent, the mode of packing, the reports of the Covent Garden dealers and of the Empire Marketing Board representative.

From these particulars it is obvious that only a limited quantity has to date been received in London in good condition ; only the very largest fruits command a market, and such have realised from 4*d*. to 6*d*. each. Smaller fruit though generally disposed of, realised only from 1*s*. to 2*s*. per dozen, and at that figure there is little or no profit to the exporter owing to the high charges for shipment in cold storage. There is as yet no regular demand and one consignment might be rapidly dis-

posed of while the next may hang about for some considerable time and prove a great loss.

Again, the condition of the fruit on arrival may lead to complications, as fruits with a perfectly sound exterior on arrival may be thoroughly unsound inside. This occurred in one consignment in 1932 when the Covent Garden dealer accepting the fruit on the value of its outside appearance was prepared to grade and dispose of these at the best rates indicated above. An assistant of the Empire Marketing Board in attendance, however, was with his more technical knowledge, able to indicate a considerable percentage of unsound fruits among the consignment, and it is obvious that because of this dealers may have some qualms in dealing with this fruit as the exports increase. As they become more acquainted with the fruit, however, this difficulty is being overcome.

The mode of transport adopted is by cases fitted with trays. Only the best fruits of approximately 3″ in diameter are utilised, these being laid in trays holding 24 to 36 each according to size of case and 4 to 5 layer trays to each case. The usual dimensions are 20″ × 13″ for cases holding 24 fruits per tray and 26″ × 13″ per case holding 36 fruits per tray, the packing material being clean wood shavings. The question of the right amount of ventilation has yet to be decided.

EXPORT TO OTHER COUNTRIES

India affords a promising field for the development of a market for Ceylon mangosteens, particularly as they can be sent as deck cargo without the need for refrigeration or special packing, but much work will have to be done in popularising the fruit before a regular demand can be created.

Apparently the name mangosteen is loosely applied to other fruit than the true one, such as other members of the Garcinia family, while in some parts the name is given to the common velvet apple.

The true mangosteen is very little known in Bengal, only small quantities reaching Calcutta from Burma or Malaya, and while the tree grows near Calcutta it rarely fruits there. It is practically unknown in Western India. A consignment shipped to Bombay last May met with a very poor reception, a large proportion being spoilt though they reached there in good condition. There is I believe an import duty of 15% preferential duty on Empire fruits (against 25% general),

whilst Ceylon admits Indian fruits duty free; and this is a matter that deserves the attention of our Government.

An experimental shipment in cold storage to Egypt too was not a success, as a large proportion of the fruit went bad before they could be sold, though they reached there in very good condition. Here too the fruit was unknown, but they created a very good impression at the start. They were distributed in the chief centres of population, Cairo, Alexandria and Port Said. The firm who handled them reported that the only person who recognised the fruit was a passenger from Ceylon, who had apparently experienced the local abnormal glut of fruit in April last, for he remarked that these could be bought in Colombo at 2*d.* a dozen and offered to buy the lot at that rate!

With the Australian port of Freemantle only 9 days' journey from Colombo and other large centres of population, but a few days' journey farther, one would imagine that there would be a ready market in that country for Ceylon mangosteens. A few early experimental consignments commanded a ready sale at high prices, as was reported in the Press at the time, but late advices from a well known firm of fruit merchants revealed the fact that more recent ones have proved very unsatisfactory, 25 to 50 per cent. of the fruit reaching Freemantle in a bad condition.

The reason for this is that shippers have been careless and have apparently sent a very poor quality of fruit obtained at random from the markets instead of paying the greatest attention to the picking, selection and packing of the fruit sent.

The mangosteen is a very delicate fruit and requires careful handling, and it is only the best quality of fruit that is worth sending out of the Island. If this is only more fully realised by local shippers all would be well.

SAPODILLA

The value of this fruit is not very well known outside tropical countries and it is the gum known commercially as "Chickle," a milky latex obtained from tapping the bark, by which the tree is more readily recognised. Chickle gum is used in considerable quantities in the United States of America as a basis for chewing gum, the source of supply being chiefly from Mexico and Central America where the tree is indigenous,

the wild trees being tapped for the Chickle mostly. It is, however, cultivated here and there for its fruit and particularly in Batavia, and latterly in South India.

As a fruit tree it attains some considerable merit and deserves to be far better known, and why it is not grown more freely it is difficult to say. It does not dislike heat and moisture but prefers semi-dry districts in Ceylon. It is not fastidious as to its soil requirements and will thrive on very light sandy soil if well cultivated and manured in the early stages. At Warriapola, Kalutara and Galle and similar localities the trees fruit freely and are of excellent quality and they have been found to do well in Jaffna also. Five or six years, however, elapse before the seedling tree will fruit though gooteed plants will fruit earlier and often in the same year as rooted. The latter method is expensive, however, as regards material and the gootee is slow in rooting, but seedlings appear to come very true to type so that for any large scale operations supplies from seedlings source would be satisfactory.

The fruit matures well before ripening so that export of the fruit over fairly wide distances should be feasible, as only when the fruit is fully ripe does the skin become soft and liable to damage. When used locally the fruit must not be wrongly judged by attempting to eat it before it is properly ripe.

Many attempts have been made to graft this fruit on to a root-stock that would shorten the fruiting period, but so far without success. At Peradeniya it has been established on the Mee and a species of Sideroxylon, but after the first flush of bud-growth has been made the budded shoot fades away and no compatible root-stock has yet been found for it, though experiments continue with species of date plum and the star apple. Further details on the cultivation of this fruit are available in the articles already mentioned, but I should add that the tree seems specially subject to scale attacks encouraged mostly by ants, and a very safe remedy for this is regular spraying with kerosene emulsion. There is doubtless a much wider market for this fruit than it has attained at present and as regards its possibilities for chewing gum purposes, a continued increase in the output and consumption has latterly resulted in cultivated trees being utilised to meet the demand since no suitable substitute for this gum has yet been found.

CITRUS

On the subject of citrus much can be done for there is to my mind far more scope here than for most other fruits

that can be grown locally, both for home consumption, and for the supply of boats in harbour and eventually for export. The subject embraces grapefruit, oranges, lemons, limes and mandarins, but for present purposes I propose restricting my notes to the low-country possibilities of grapefruit, limes and mandarins. There does not appear to be any great demand here for lemons as there is in other countries, although it is the easiest of the citrus to grow, very prolific in crops and is less subject to pests and diseases than the others. Oranges, as regards the well known types such as Washington Navel, Valencia and such like, I would classify as mainly a mid-country crop, for elevation is essential if a good quality fruit is to be obtained, and this combined with semi-dry conditions as in the Uva Province and any similar locality. A Department Leaflet No. 59, goes fully into the subject of grapefruit and oranges, the article covering the present position of the industry, root-stocks suited to Ceylon, orange and grapefruit varieties, propagation and planting, cultivation, manuring, pruning, crops, diseases and insect pests, and I would advise a careful perusal of this article.

Ceylon must realise the importance and the increasing extent to which the cultivation of citrus is now taking place in other tropical agricultural countries and particularly in the West Indies where conditions are in many cases so identical with our own. The Director of Agriculture, Jamaica, in a recent Bulletin states that his Department in association with the Jamaica Agricultural Society, is doing everything possible to encourage and assist the planting of citrus in districts where conditions are favourable, and it is hoped that these efforts, in conjunction with those of a large number of interested people in various parts of the Island, will bring about a great increase in production of citrus fruits within a few years, with consequent benefit both to those engaged in the industry and to the whole Island.

Considerable differences of opinion still exist in Jamaica in regard to the methods which should be employed during the various stages of propagation, planting and cultivation of citrus, and it was felt desirable that those officers charged with duties in connection with the Government Citrus Extension Programme should meet in conference with a view to full discussion of the various questions involved so that uniform methods of cultivation and culture in relation to local conditions could be agreed

upon, and a statement issued for the formation of those now engaged upon or proposing to take up the cultivation of citrus.

The conference comprised the Director of Agriculture, the Secretary of the Jamaica Agricultural Society, the Officer of the Government Citrus Experiment Station and four other agricultural officers. The proceedings of the conference were embodied in a memorandum setting out the main points which should be carefully followed by those who are devoting serious attention to the planting of citrus.

The memorandum subsequently circulated covers much the same ground as my leaflet No. 59 already referred to, due allowances being made for our lower latitude and more varied conditions. Trinidad already has a footing in the export of citrus to Great Britain and other countries, as well as other of the West Indian Islands which are rapidly following her example.

We in Ceylon have land in plenty with varied soil and climatic conditions, sufficient labour; and in my opinion there is now sufficient data on which to proceed in the opening up of a considerable number of orchards or groves on most up-to-date lines.

It is, of course, realised that the normal seedling of most fruit plants show many degrees of variation from the parent and it would be a mistake to contemplate citrus orchards anywhere nowadays from seedling trees. For commercial success in any fruit enterprise the quality must be of the highest, all trees must be productive to their fullest extent, kept healthy and vigorous and planted on a sufficiently large scale.

As is the case with most other fruits, propagation of citrus by means of budding is necessary. The desiderata seem mostly to be a need of capital and of enterprise, the latter at the moment in respect to the raising of locally budded plants. It is regrettable that, so far as my knowledge goes, not a single nursery dealer in this country can at present produce the budded citrus plant from his own resources, all being merely content to import the plants and retail them as the demand is made for such. There is no objection to this up to a point, since imported material of good strain is first necessary before local buddings can be produced, but it is a very costly means and inadvisable in other respects to attempt any large scale operations on orchard lines from imported plants. Apart from high initial costs it is not certain that the root-stock of the imported budded plant is suited to our varied conditions.

South Africa and Australia are the present sources of supply and the root-stock there used is the rough lemon and varieties of the lime.

Certain root-stock experiments have been made at Peradeniya and are in progress, to ascertain the best root-stocks for our varying conditions, and in *The Tropical Agriculturist* for August, 1935, a summary of work on fruit at Peradeniya details the results achieved to date. These are, that for the moist low-country up to 1,500 feet or so the pumelo is principally recommended, from 1,500 feet and throughout the moist zone in mid-country and also for semi-dry regions the Seville orange is recommended and for dry and semi-dry regions the rough lemon is recommended.

There are, of course, other root-stocks under trial and with further experiments it is most probable that in the dry and semi-dry zones some of our local Rutaceae may furnish a useful root-stock.

Grapefruit is recommended as an orchard tree under conditions varying from sea level to 3,500 or 4,000 feet in the moist and semi-dry regions and in the dry zones under irrigation, and on the respective root-stocks already mentioned. The Indian loose skinned orange or mandarin is likewise recommended for the same localities, whilst for the Australian and South African varieties of oranges these are best restricted to mid-country moist and semi-dry regions on the Seville orange root-stock. Limes are generally a more semi-dry region product or dry region also where irrigated, but are grown in the moist zones also up to 3,000 feet, though these do not give the same returns in the moist as in the drier regions. There are several varieties of lime and the local country lime is quite a good type. The spineless and the seedless forms are rare, but the British Guiana lime is an introduction that has now become widely distributed.

This variety is specially recommended on the ground of its bearing fruit practically all the year round in the moist zones, whereas the local lime does not as a rule fruit during prolonged periods of drought or during very wet weather.

The articles go fully into the planting, cultivation and upkeep methods of these various types of citrus and the information need not be repeated here.

A very important factor in citrus cultivation is, however, the question of pests and diseases. Good cultivation, well

maintained, will throw off many pending attacks, but where these occur they can be very troublesome. One of the commonest diseases in the wet zone is citrus canker denoted by yellow spots on the leaves which later become corky, eruptive growths of a brownish colour occurring on the leaves, branches and the fruit. It is the young leaves that are mostly affected and these where attacked should be picked within reason and burnt.

The control measures as advocated by the Government Mycologist are the use of windbreaks where possible, the cutting out and burning of any affected branches or leaves and regular spraying during wet weather of 1 oz. Solol, 1 oz. Sulsol to one gallon water, every week or once a fortnight in dry weather.

Mildew or Oidium can also be troublesome, but dusting with flowers of sulphur and a lime-sulphur spray keeps this in check.

The most important local pests are the citrus leaf-miner and the citrus leaf-roller, both of which are dealt with by the Government Entomologist in *The Tropical Agriculturist* for September, 1934, the control in each case being regular spraying with a concentrated ready-made oil emulsion containing a small percentage of nicotine used at the rate of 1 oz. to a gallon of water, or concentrated nicotine sulphate solution used at the rate of 1 oz. to 2 gallons of water, adding an ounce of soft soap when making the mixture in either instance.

A further trouble, particularly experienced in up-country gardens on oranges is "sooty mould," a fungus which lives on the secretions of the scale insects found on the trees. This in itself is not very harmful in small quantity, but if not not attended to will retard growth by reducing the amount of light to the leaves whereby the work of the leaf chlorophyll is checked in its food manufacture.

The remedy is a kerosene emulsion spray or a 1 per cent. to 2 per cent. lime-sulphur spraying till the scale insects are driven off, after which the rains will usually wash off the sooty mould. It is advisable, however, to give regular sprayings to keep off the scale and thereby the black sooty mould.

In concluding these notes on citrus I should mention that Great Britain is the chief importer of citrus fruit in the world and the proportion of these supplies originating from Empire sources is increasing. There is then a good market for any future supplies of citrus, and particularly grapefruit,

that we can raise in the near future provided, of course, that the quality is up to standard and that the fruits can be marketed at a competitive rate. Though it would be difficult to cope with other countries in an open market in oranges, the same does not apply to grapefruit, since being a more tropical poduct supplies of this fruit are already being received in home markets in increasing amounts from similar localities to ours in the Western tropics. The West Indies alone now produce from 6,000 to 7,000 tons of grapefruit, a large proportion of which is exported to Great Britain.

One might well now ask, how to go about this work of citrus extension ? As already stated lack of supplies of locally budded plants will be the first drawback. Peradeniya has done and is doing all possible, and our nurseries are worked to the limit, but the area available comprises little more than $1\frac{1}{2}$ acres into which not only citrus, but fruit stocks of all varieties have to be housed and maintained. In addition to this, being a Government institution financed by Government funds the policy pursued is to supply the greater number of applicants with a few plants each rather than few applicants with a large number each. This leads nowhere however as regards growing fruit on orchard or commercial lines.

There is at present a very large demand for locally budded fruits of all kinds, but particularly citrus, and I have received in the past year many requests, the latter varying from 50 to 1,500 plants from individual applicants, and we are, of course, unable to supply anything near that quantity from Peradeniya.

The policy was, therefore, decided on a year or more ago that a section of the present Experiment Stations and plots in the localities where citrus is considered a possible future enterprise should be opened up in citrus with a view to providing good budded material on a scale large enough to meet the local demands in orchard quantities. At the Pelwehera Experiment Station near Dambulla an area of $2\frac{1}{4}$ acres was planted with imported citrus types considered suitable to that locality, including grapefruit, mandarin, the Nagpur loose skinned mandarin and oranges.

These are growing remarkably well in spite of the recent drought and will, on fruiting and testing as to their true to type characters, be sources of potential budwood for the station and for the locality. Coincident with this a nursery area capable of raising 15,000 seedlings was opened and stocked as far as

seed supplies allowed, the rough lemon being the main type utilised, and quite latterly the first batch of these seedlings were budded from budwood of mature trees of the Nalanda Experiment Station. This work on budding will, of course, proceed more rapidly as the seedling root-stocks in the nursery become available.

An inspection of this area is invited as it indicates the lines on which orchards in the semi-dry zones should follow. The planting of the orchard is on the triangular or alternate system $18' \times 18'$, with gliricidia in and between the rows, and holes 3′ wide by $2\frac{1}{2}'$ deep were prepared for the plants, and well manured in refilling. The question of the suitability of a ground cover under the local rainfall conditions has yet to be decided.

There is much that could be learnt from a personal inspection of this area and the intention is, I believe, that other stations being similarly opened out or to be opened should in general follow on the lines here indicated.

These are some of the Department's activities in pushing on the cultivation of citrus, but it should not be left at this. Any private individual with land and sufficient capital at his disposal could work on similar lines and raise his own requirements, for well trained budders are available at Peradeniya to be sent out wherever required for this work when the budding stage is reached, and the local Agricultural Instructor is at his disposal for any advice required. Only by a pursuance of such a policy will any advance be made in the cultivation of citrus or other fruits.

AVOCADOES

The avocado is a fruit that must be restricted to mid-country conditions if the best results are to be obtained, but it is mentioned here as it is probable that this fruit or salad will become very popular in time to come owing to its nutritive value. The fruit is grown and consumed in large quantities in the Western tropics, but is not too well known in the East at the moment.

The variety at all common in Ceylon is a green skinned West Indian type of average merit and grows best between 1,000 and 3,000 feet elevation in the moist zone. There are now many varieties varying in their hardiness under the groups

West Indian, Guatemalan and Mexican avocadoes, the groups referring to tropical, intermediate and sub-tropical types respectively.

American and other horticulturists view the avocado as one of the greatest undeveloped sources of food which the tropics offer at the present day, and they predict that avocado culture may in time rival that of citrus culture. They have in fact of late years given systematic attention to cultural methods, vegetative propagation, and to the development of superior varieties with the aim of placing the avocado in the position of a staple food crop rather than a luxury or salad fruit. To assist this object the Californian Avocado Association has exerted considerable influence in effecting its improvement. It renders valuable service in the study of the numerous varieties in cultivation, recommending only those of outstanding merit and suitability for commercial planting and provides literature of much assistance to the grower. A Co-operating Marketing Agency was founded in 1924 to cope with the marketing of the rapidly increasing crops and is increasing its functions at the present time. It is in a comparatively young stage as an orchard fruit in America only a few thousand acres being under cultivation, though this is increasing rapidly, and the fruits can now be found in the European markets.

The present position of the fruit in Ceylon can no doubt be improved by the use of some of the many varieties raised in America, but the question needs study as in other parts it is found that one particular variety often suits only a particular locality and not all give of their best under the same conditions. Propagation by budding is of proved merit, but here again the root-stock is of importance. The root-stock commonly used in America is the Mexican (sub-tropical) variety and new varieties of plants so grafted have been established at Peradeniya for many years now. It is noted, however, that after the first or second fruiting the plants begin to sicken and show signs of unsatisfactory root growth and at 8 to 9 years of age the imported trees are of little use. Buddings made from these imported trees on to local common avocado as a root-stock have resulted in very fine and vigorous plants and it seems that the best varieties, so budded, should open up future prospects for this fruit.

The composition of this fruit as analysed in the University of California is interesting in that the fat content is in some

varieties very high, varying from 10 to 30 per cent. of fat and only the olive compares with it. The edible dry portion of a good avocado is greater than in any other fresh fruit, even the banana, being 30 per cent., with protein content 2 per cent. also higher than that of any other fresh fruit, and percentages varying from 5 per cent. to 9 per cent. of carbohydrates. The latter is not high compared to other fruit because the avocado contains almost no sugar. The ash, or mineral matter, in the fruit is very high varying from 0·85 per cent. to 1·56 per cent. this including Soda, potash, magnesium and lime.

The composition of this fruit is particularly stressed, owing to its outstanding value as a food. It can be eaten in the form of a salad with other ingredients or alone with pepper soda, potash, magnesium and salt to season.

Seedling trees attain some considerable height, but budding dwarfs the tree and renders it of very suitable size for orchard purposes. The fruit, in its many varieties differ in colour, form and size, the colour varying from our local deep green to a purple and maroon and the weight from a few ounces to 2 or 3 lb. per fruit. Averaged sized fruits of roughly $\frac{3}{4}$ lb. each are, however, mostly in demand.

Seed of the Mexican stock plant has been received at Peradeniya and a combination in budding of the Mexican root-stock with Mexican variety of scion should result in this tree being successfully grown at much higher elevations than our local variety can be grown. Because of this variety of root-stock and scion, America can supply the market for 10 months out of the 12 each year.

CONCLUSION

Space does not, I fear, permit me to comment on the remaining fruits, but I think all those that can be termed major fruits have been discussed, if one excludes the up-country cherimoya, a fruit little known as yet, but one with potentialities equal to any so far dealt with, for the higher elevations.

The main point in my opinion that accounts for our present backwardness in fruit culture, as compared to other countries similarly situated, is the the lack of enterprise and initiative of the individual and the hesitation and paucity of capital, locally, to take up a new venture. Too much is expected of the Agricultural Department which has in its time, by experi-

ment and trial, furnished quite a respectable amount of data on the majority of fruit and vegetable products.

Advice is available on all cultural and upkeep methods from the seedling to the mature plant, in the control of pests and diseases, and now extends to the preserving, bottling and canning of the mature product. Further activities will doubtless follow in the direction of packing, grading, marking and marketing of the product when this is produced in sufficient quantities, but the one outstanding desiderata at the moment are first to *grow your fruit*, and to *grow more fruit*. Obviously until crops are produced in fairly large quantities and over a fairly wide seasonal range such steps are premature.

A point I would again much like to emphasise here is that whatever the type of fruit taken up only the best varieties should be considered and these should be grown on proper scientific and up-to-date lines. With few exceptions, this is not the case at present, for applicants to Peradeniya for fruit supplies show that the majority are concerned, not with the quality of the fruit so much but with the cheapest possible rate at which the seedling or graft can be obtained.

Within the past few years the normal Departmental rate for fruit plants have been revised and reduced, a very acceptable fact in itself no doubt, but it tends to cut the throat of the private nursery or fruit tree supplier whose assistance at this stage is so urgently needed. It should also be recognised that a good fruit plant has its value at competitive rates, and beyond this stage a cheaper plant becomes dear in the end.

America, both in the supply and quality of material and in the production of the finished agricultural product, probably leads the world, and in conclusion I would like to quote Mr. Wilson Popenoe, American Agricultural Explorer, in his book on Tropical and Sub-tropical Fruits. In his outlook on tropical fruits he points out much that has been emphasised here to-day. He opines that many tropical fruits, not all of them important, yet all valuable in varying degree in the dietary of the race, must be grown in ever increasing quantities not only to supply Northern markets with their teeming population, but to enable the indigenous population of the tropics to obtain abundantly and cheaply this most wholesome source of human energy. For strange as it may seem to many who have never lived or travelled in tropical countries, the conventional idea that luscious fruits grow upon every tree is far from realised.

It is a well attested fact that inhabitants of many tropical countries suffer for want of sufficient fruit which could so easily be averted by plantings on a more wholesale scale. He notes indeed that only scattered and often neglected specimens of such exist, though mango and certain others receive some attention, but that even these rarely receive more than a fraction of the care that is in Northern countries lavished on apples, peaches, etc.

This is all too true, and the Agricultural Department and the private individual in the form of local fruit associations should get together on this very important question of the extension of areas and further supplies of all fruits. In our case, however, let us first cater for and attain an increased home consumption, after which supplies to boats in harbour and exports abroad will automatically follow.

DEPARTMENTAL NOTES

A NOTE ON THE BAGGING OF GRAPE FRUIT

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PROFITABLE grape fruit cultivation implies the production of readily marketable fruit of good quality, fair and even size and free from unsightly blotches of citrus canker and the less easily seen but more serious fruit-fly injury. The flavour of Ceylon grape fruit though more acid and possessing more of the characteristic grape fruit bitterness than imported fruit is pleasing when the fruit is properly prepared. Many people prefer the flavour of local grape fruit and raise no objection to the slightly coarser flesh. The presence of too many seeds is undesirable, but seeds are easily removed during the preparation of the fruit for eating. Good strains of Marsh's Seedless are seedless or almost seedless. Only reasonable and even-sized fruit should be marketed if grape fruit growing is to expand into an industry in Ceylon. The writer has recently seen offered for sale grape fruit no larger than a small orange and it cannot be doubted that the marketing of fruit of this sort will destroy a valuable potential demand. Good cultivation to reduce the number of small fruits produced and rigorous grading must be practised.

Citrus canker (*Pseudomonas citri*) is found on most citrus trees in Ceylon and although it can be kept in check in the drier regions by the frequent removal of affected fruit, leaves and branches, combined with regular spraying*, control has been found difficult at Peradeniya and even at Bibile. On the Experiment Station removal of affected leaves has with some plants resulted in such a degree of defoliation that development has been arrested. Many trees which by now should be in bearing have the appearance of being no more than two years old. Extensive defoliation, unless the disease is completely

* The spray at present recommended is made up of 1 oz. Sulsol, 1 oz. soft or ordinary soap, ¼ oz. nicotine sulphate to 1 gal. water.

eradicated, would appear to be impracticable and whether complete eradication is possible or not still remains to be seen. In the meantime a practical method of keeping the fruit free from canker is to enclose every fruit soon after it has formed, and while it is yet only an inch or so in diameter, in a grease-proof paper bag. Generally single fruits are bagged but it is sometimes more convenient to use a larger-sized bag for two or even three fruits. A small perforation should be made in each corner of the bag to allow rain water to escape before it collects in sufficient amount to cause the gummed edges of the bag to give way. The cost of bags ($9'' \times 10\frac{1}{2}''$) for single fruit is about Rs. 6 00 per 1000 and of bags ($10\frac{1}{2}'' \times 15''$) large enough for two or three fruits Rs. 10·00 per 1000.

The fruit-fly (*Dacus ferrugineus*) is a serious pest of grape fruit in many places in Ceylon. Eggs are laid in the ripening fruit and small white maggots have developed by the time the fruit is ripe. The presence of these maggots make the fruit unsalable. It is not always possible to determine if a fruit has been attacked and if a purchaser finds maggots in even a few fruits the demand for Ceylon fruit will be seriously affected. It is essential, therefore, in the interests of grape fruit growing to make certain that all fruits marketed should be free from fruit-fly damage. Although fruit-flies can be kept in check by natural parasites and can be destroyed by poisoned baits the safest and most practical method of preventing attack is to bag the fruits.

So far as can be determined from several months experience on the Experiment Station bagging gives complete protection from canker and fruit-fly. It may occasionally happen that the very young fruit is infected by canker before bagging. No serious drawbacks to the use of bags have been observed; pink patches have been noticed on some bagged fruits, but these have apparently no effect on the flesh.

On the Experiment Station almost ripe fruit are plucked, washed with soap and water and, in order to give a more pleasing appearance, coloured by acetylene gas in a home-made gassing chamber.

PROGRESS IN THE DEVELOPMENT OF CROPS IN THE HAMBANTOTA DISTRICT

G. HARBORD, DIP. AGRIC. (WYE)
DIVISIONAL AGRICULTURAL OFFICER, SOUTHERN

COTTON

MUCH work has been done to induce more widespread cultivation. For the present crop (1935-36 season) cotton seed to a total of 3 tons 7 cwt. has been issued for sowing. There is a decided increase in the area under crop this year, probably totalling 750 acres, distributed thus :—

East Giruwa Pattu	..	500 acres
Magam Pattu ..	..	200 ,,
West Giruwa Pattu	..	50 ,,

So far, prospects are good.

TUTICORIN CHILLIES

Our efforts to induce chilli cultivators to cultivate an area of chillies suitable for curing in addition to the local variety for green chillies, have been intensified this year, and for this purpose we have given out as free issues to interested cultivators around Middeniya and Bata-ata 860 lb. of selected Tuticorin and Indian chillies for sowing purposes :—

Middeniya	..	488 lb.
Bata-ata	..	372 lb.

FODDER GRASSES

The cultivation of fodder grass as food for cattle is an unknown practice throughout the Hambantota District.

This practice and the stall-feeding of cattle is the first essential step towards any systematic improvement in the breed of Ceylon cattle. This fact is well recognised by the Ministry of Agriculture, and special instructions have been received to encourage cattle owners to open up fodder grass fields as widely as possible.

Efforts in this direction have met with considerable success in the Matara and Galle Districts where conditions may be said to be more suitable.

It is now proposed to make a beginning in the Hambantota District. If the feasibility of the practice, as far as Hambantota District is concerned, is doubted, then sceptics would be well advised to visit the Experiment Stations at Bata-ata, Weeraketiya and Middeniya where excellent crops of Guinea grass and Napier grass are being raised under "dry farming" conditions.

West Giruwa Pattu is particularly favourable for the growth of fodder grass. Fodder grass responds readily to infrequent irrigation which is a point worth remembering when the cultivation is attempted anywhere eastward of Ambalantota.

PURELINE PADDY

1. The cultivation of Suduheenati is now widespread throughout the Kirindi and Walawe Irrigation Schemes, and in the Weeraketiya and Ranna localities it is now recognised as a desirable paddy, and is in demand.

2. This particular rice is much sought after by consumers in the larger towns -Matara and Galle—and even Colombo, and there is no doubt that if a Co-operative Sale Society was established at a suitable centre- such as Ambalantota—it would prove a great stimulus to the cultivation of Suduheenati, and it could also work up a profitable business in supplying the wants of consumers.

3. The work of developing the old cotton station at Ambalantota into a paddy experiment station has been started, and 20 acres are now under crop for the Maha season.

Acreage.	*Variety of Paddy.*
10 acres ..	Suduheenati (Pureline)
10 acres ..	Murungan (Local)

Besides raising stocks of pureline seed, this Station will investigate and demonstrate the value of various cultural implements and fertilisers.

IMPLEMENTS FOR PADDY CULTIVATION

All Agricultural Instructors' Ranges have now been provided with stocks of Arumugam ploughs and Burmese harrows for demonstration purposes, and for issues on loan to approved cultivators.

Considerable interest in the use of tillage implements for paddy cultivation has been aroused at Tissa, and it is hoped that paddy growers of the Walawe Right Bank Scheme will soon take a similar keen interest in these implements.

FOODS WE EAT AND WHY WE EAT THEM*

AT the Pennsylvania State College we have a student dining room which the architect has designed as a Pennsylvania Dutch grill. Over the counter from which the foods are served there is inscribed in German script the Pennsylvania Dutch motto, "Sak mir was du esscht und Ich sak dir was du bisscht." This is the Pennsylvania Dutch equivalent for the old maxim, "Tell me what you eat and I will tell you what you are." A recent writer has paraphrased this maxim by saying, "Tell me what you eat and I'll tell you how old you are." He informs us that it is possible to divide the span of human life into eleven dietary or gastronomic ages, which fall in the following chronological order :—

Age No. 1—Milk.
,, ,, 2—Bread and milk.
,, ,, 3—Milk, eggs, bread and spinach.
,, ,, 4—Oat meal, bread and butter, green apples and all day suckers.
,, ,, 5—Ice cream soda and hot dogs.
,, ,, 6—Minute steak, fried potatoes, coffee and apple pie.
,, ,, 7—Bouillon, roast duck, scalloped potatoes, French rolls, creamed broccoli, fruit salad, divinity fudge and demi tasse.
,, ,, 8—Pate de foies gras, wiener schnitzel potatoes parisienne, egg plant a l'opera demi tasse and Roquefort cheese.
,, ,, 9—Soft boiled eggs, toast and milk.
,, ,, 10—Crackers and milk.
,, ,, 11—Milk.

While it is clear that this writer was poking fun at our dietary inconsistencies, he was also emphasizing a very important dietary truth, *viz.*, that milk plays a very important part in giving us the proper start in life and that we instinctively revert to milk when we have reached the age when our digestive organs begin to show the results of unwise dietary excesses of former years.

Our knowledge of foods and food values has undergone many changes as a result of chemical and nutritional researches. Hippocrates (460-370 B.C.) believed that there were many kinds of food but that there was but one single substance in foods which was necessary for normal growth and development. As late as 1813 the eminent French physiologist, Richerand, still adhered to this hypothesis. Twenty years later (1833) Dr. William Beaumont published his classical work on gastric digestion and at that late date he referred to the nutritive value of foods in terms of a single substance which he called "aliment." It would be very easy to solve our dietary

*By Professor R. Adams Dutcher, Department of Agricultural and Biological Chemistry, Pennsylvania State College in *The December Scientific Monthly.*

problems if this theory could be shown to be correct. Unfortunately for the layman, each new discovery in food chemistry seems to make the problem more complex.

Dr. William Prout, an English physician, was one of the first scientists to " complicate the picture " when he announced in 1834 that foods contain at least three essential types of materials which are necessary for good nutrition. These substances were called albuminosa, oleosa and saccharosa, which are known to us as proteins, fats and carbohydrates.

Justus von Liebig, of Germany, was largely responsible for the conception that fats and carbohydrates are used largely as sources of heat and energy in the animal body, while proteins function primarily as building materials for body tissues.

As chemistry developed, foods were classified according to their content of these three substances, and the first feeding standards for humans and domestic animals were, naturally, chemical standards. The first period therefore, might well be called the " chemical period " in nutrition. This was followed by a second period, which might be called the " energy period," in which food values were expressed in terms of calories or heat units. It was not long, however, before it became evident that diets could be compounded from chemically purified proteins, fats, carbohydrates and mineral salts, which conformed to the best of the chemical and energy feeding standards and yet lacked something necessary for normal growth and reproduction.

A new method of research was devised, using chemically purified diets and small experimental animals, with the result that a new (biological response) period came into existence. This period of research has led to what is popularly called the " Newer Knowledge of Nutrition." During this period three important types of discoveries were made, which have had considerable influence on the food habits of the American people.

Prior to this period chemists and nutritionists believed that all proteins regardless of source, possessed the same nutritive value because they all contained about the same amount of nitrogen. The new work with small animals proved that this is not the case— since animals grow better on some proteins than they do on others. Subsequent investigations by the ever curious research chemist led to the discovery that proteins of high biological value contained many amino-acids (which act as building stones for body tissues), while the poorer proteins were found to be lacking in some of these amino-acids which were needed by the body tissues.

When the missing amino-acids were added to the inferior proteins or when other proteins were added to the diet, rats again grew normally. Thus, the first important lesson to be learned is that, as a class, individual animal proteins are nutritionally superior to individual vegetable proteins and that the wise mother will plan her meals in such a manner that her growing children will be certain to receive all the amino-acids necessary for the construction and repair of muscles and similar tissues. This can be done by supplementing the important energy-producing foods, such as bread and cereals with vegetables, milk, eggs and meat.

The second discovery that resulted from work with small animals had to do with the mineral salts in the diet. Scientists already knew, of course,

that the growing child and even mature people must have mineral salts in order to construct strong bones and teeth and keep the blood and body fluids in healthy condition. They had the feeling, however, that the mineral problem "sort of took care of itself" if the other ingredients, such as proteins, fats and carbohydrates, were provided in ample amounts.

The biological response tests with small animals soon exploded this idea, for it was found that some of our daily diets were woefully lacking in certain mineral or inorganic salts. This type of research also led to a better understanding of the individual functions of the common inorganic elements, such as calcium, phosphorus, magnesium, sodium, iron and chlorine. Much to our surprise we began to discover that some of the rarer elements, such as copper, iodine, manganese and even zinc, might be vitally essential for health and well-being. In former years copper was considered a member of the "poison family"—to be gastronomically avoided. Biological tests have shown, however, that copper in traces has a very beneficial effect on the utilization of iron and helps us to build better red blood cells.

It is entirely possible that we may find eventually that practically all the inorganic elements have a definite function to perform, in spite of the fact that they are present in almost infinitesimal traces. Iodine is a case in point. When it is absent from the soil, food crops and waters—such as we find in goitrous regions—excellent prophylactic results can be obtained by eating foods or drinking water containing very small quantities of iodine. Again the conclusion seems inevitable—that we are more likely to obtain the mineral salts we need, if we will vary our diet sufficiently to ensure a varied supply of mineral elements.

I have already pointed out that milk contains proteins of high nutritive value. Milk also contains a very desirable mixture of inorganic salts. In fact, milk is our best single source of calcium, and research has shown that it is quite difficult for the growing child to obtain its daily calcium requirement unless it receives from a pint to a quart of milk daily. It is not necessary to drink this amount of liquid milk to obtain this amount of calcium. It is possible to ingest a portion of the milk as dried or evaporated milk in cooked foods, puddings, etc. The vegetables, particularly the leafy vegetables, also contribute appreciable amounts of calcium and other valuable mineral elements, such as iron. Thus we have learned to drink more milk and eat more vegetables and fruits in order that our mineral salt supply may be adequate for normal health and well-being.

A third discovery that developed from animal experimentation was even more unexpected and unbelievable, *viz.*, the discovery of vitamins. It was found that some foods did not contain these mysterious chemical substances and if these foods were fed for long periods of time (without supplementation with other foods) animals ceased to grow, failed to reproduce and developed disease symptoms identical with or similar to human diseases that have been known by the medical profession for centuries. It was soon possible to produce experimental dietary diseases similar to if not identical with human beriberi, pellagra, rickets and scurvy. Then discoveries came so fast that even the research workers themselves had difficulty keeping up with the newest developments.

Vitamin A received considerable front page publicity because its absence from the diet caused loss of weight, respiratory diseases and blindness in

rats, which could be prevented when milk, butter fat, egg yolk, fish liver oils, carrots or pigmented leafy plants were added to the diet. The world war presented an opportunity to test the value of rat experiments on humans because children in Rumania and Denmark were deprived of dairy products which resulted in pathological eye symptoms similar to those produced in vitamin A-deficient rats. When Denmark discovered that she was selling her milk and butter at the expense of the health of her children, she eliminated the eye disease by regulating the amount of dairy products that could be shipped from the country. In Rumania the problem was solved by administering cod liver oil to all children.

Brilliant researches of the past few years have shown that the yellow pigment carotene, found in carrots and many plants, can be changed into vitamin A by the body tissues. The cow takes this pigment from her feed, changes a portion of it into colorless vitamin A and excretes the excess of yellow pigment in the milk, where it is available for us to transform it to vitamin A in our own tissues. Guernsey and Jersey cows cannot change this pigment into colorless vitamin A quite so readily as the Holstein and Ayrshire breeds, with the result that butter fat from the former is more yellow than that from the latter, but the total biological values (from the stand-point of carotene and vitamin A) are equal, the former being richer in the pro-vitamin, carotene, but poorer in colorless vitamin A. The reverse is true for Holstein and Ayrshire butter fats, since they contain more of the colorless vitamin A but less of the yellow carotene. Since Guernsey and Jersey milks usually contain higher percentages of butter fat, the total vitamin A effect of the milk may exceed that of the non-pigmented breeds. These are no longer mysterious substances, for we are now able to write the chemical formulae for vitamin A and for carotene.

Vitamin B or B1 (anti-beriberi vitamin) has now been crystallized and its chemical formula is practically assured. This vitamin is necessary for normal health, appetite and growth and is found in cereals, yeast, milk, leafy vegetables and fruits.

Vitamin C is now being manufactured artificially by the pound, its chemical structure has been determined and the chemist calls it ascorbic acid. When we eat liberal amounts of oranges, lemons, tomatoes, fresh cabbage, lettuce and similar foods we are certain to obtain sufficient quantities of this scurvy-preventing vitamin.

An artificial type of vitamin D (known as activated ergosterol) has also been crystallized. It has been obtained in pure form and its chemical formula is known with a fair degree of certainty. This rickets-preventing vitamin is necessary for the proper building of bones and teeth in growing children. Our best natural sources are the fish liver oils. Milk does not contain it in satisfactory amounts, as a rule, which accounts for the fact that we find various types of vitamin D milk on sale which have been supplemented with various forms of vitamin D.

Vitamin E, the fertility or anti-sterility factor, will not be discussed because its clinical importance has not yet been fully established.

Vitamin G or B_2 promotes appetite and well being. Without it a number of pathological conditions develop of which a pellagra-like skin disease is the most outstanding. We find this vitamin in many foods such as yeast, whole cereals, milk, vegetables and fruits. Investigations of the past few months indicate that vitamin G (B_2) consists of two separate substances. One of these is a yellow pigment called "flavine" which is thought to be necessary for growth. The other fraction, tentatively called vitamin B_6, is thought to be specific in preventing and curing a dietary dermatitis in rats which is similar to pellagra in human beings. A number of other "B Vitamins" have been suggested, but we have no information to date that they have any importance in human nutrition.

The newer knowledge of nutrition has taught us to be reasonably careful to supplement our daily diet of meat, bread and potatoes with the "protective foods," such as milk, eggs, fruits and vegetables. It is unwise and unscientific to condemn wholesome foods merely because they are lacking in certain dietary essentials. It is much safer and more economical from a health stand-point to supplement such foods with reasonable amounts of milk, eggs, vegetables and fruits.

RECENT CONFERENCES AND CONGRESSES

[The following summary of the discussions which took place at four important Conferences and Congresses held during 1935 is reproduced from *Tropical Agriculture*, XII, No. 12, December 1935. It was prepared by the Editor of that Journal mainly from Reports in *Nature*, Vol. CXXXVI, Nos. 3434; 3436; 3440; 3441 and 3442. It should be of interest in view of the fact that Ceylon was represented in all four instances by Staff Officers of the Department of Agriculture while on leave.—Editor, *The Tropical Agriculturist*]

The past summer witnessed several conferences and congresses which afforded further evidence of the progress recently achieved in various branches of agricultural science. The series of meetings of particular interest to us may be said to have begun at Oxford where the Third International Congress of Soil Science was held. This was followed by the Third Imperial Botanical Conference in London, and early in September, by the Sixth International Botanical Congress in Amsterdam. Later in that month, the Fourth Imperial Entomological Conference was summoned in London. It is impossible here to give detailed accounts of these conferences, but an attempt will be made to convey a general impression of what took place.

At Oxford, Sir John Russell, in his presidential address dealt with the contribution of soil science towards improving economic conditions and laid stress in particular on the value of the surveying and mapping of soils as a preliminary of all schemes of agricultural development. In this connection Professor F. Hardy's paper on " Some Aspects of Tropical Soils " may be cited, in that it described quantitative soil profile investigations which, in the Carribbean area, have rendered possible the exact definition of soil best adapted to the growth of several important orchard and field crops, and have made manifest certain soil factors that are definitely harmful to those crops. This aspect of soil work, of which the aims and methods differ widely in different countries, was dealt with by the commission on Soil Genesis, Morphology and Cartography, and by that on the application of soil science to land amelioration. In the Soil Fertility Section of the Congress, considerable interest was displayed in the methods used for estimating the manurial requirements of soils. Professor E. A. Mitscherlich presented the first results of a great co-operative investigation, in which already 120 soils from different parts of the world have been studied, using more than 30 different methods. This investigation is a model of what can be attempted by international co-operation. Professor O. de Vries described the scope of the very large number of field experiments which are being carried out in the Dutch East Indies, and Professor R. A. Fisher, in his demonstration of the principles of the design of field experiments, made clear what is often overlooked, that accuracy alone is not enough unless the degree of accuracy is also known. In the Soil Physics Section, Dr. R. K. Schofield introduced a " PF " scale which precisely specifies the degree of wetness or dryness of a soil in much the same way as the PH scale specifies the degree of acidity or alkalinity. By carefully distinguishing wetting and drying conditions, it was shown that

a more rational interpretation could be applied to data on plant wilting and field moisture capacity. In the Chemistry Section, much attention was directed towards the base-exchange properties of soil colloids, particularly from the mineralogical point of view. The very large number of papers dealing with practical soil science emphasised the dominating influence exerted on its development by modern economic conditions. In certain countries soil scientists have almost been driven to produce practical results with insufficient knowledge of the fundamental nature of the soil, and there was a feeling at the Congress that real advancement in pure or applied soil science would depend on the solution of those fundamental problems which so far research workers had been unable to tackle.

The Imperial Botanical Conference was opened by Sir Arthur Hill, who emphasised the ever increasing importance of botanical research in the development of Imperial agricultural resources, not merely with regard to export crops, but also to the food plants of the native and his animals. The study of native crops with the view of obtaining maximum yields under the various local conditions is a work of the greatest national importance which calls for the continued co-operation of botanical and agricultural workers at home and overseas. The Conference confined itself to problems of special Imperial interest, and to the organisation of research. A series of papers on "Pasture Research within the Empire," introduced by Professor R. G. Stapledon, dealt with the importance of 'strain' in pasture plants. The need for safeguarding the original stock of particularly desirable 'strains' or 'groups of strains' was stressed. Dr. Pole Evans described the natural pasture areas of South Africa to which much damage has already been done by indiscriminate grazing, by burning and by other mal-practices. This was ascribed to a general absence of fundamental knowledge relating to the problems of veld management. A national research programme has now been organised, however, which will deal in particular with problems relating to the general decline in the carrying capacity of the veld due to faulty grazing methods. Mr. Martin Jones dealt with the competition to which the constituents of grassland are subjected by neighbouring plants, and showed how differences in habit or rate of growth lead to the dominance of certain forms or the suppression of others. Grazing by animals is of the greatest importance in this connection, the effects on the development of any particular constituent varying according to the intensity of grazing at any given period. In a session devoted to "Succession of Tropical Forest Types," Dr. Burtt Davy dealt with the evolution of tropical African forest types, Mr. P. Topham described the distribution of forest type in Nyasaland, Mr. W. D. MacGregor of various Nigerian forest types in relation to temperature, rainfall and elevation, and Mr. P. Richards gave a comparative account of three areas of tropical rain forest situated in British Guiana, Sarawak and Nigeria respectively. Of peculiar interest was Mr. C. G. Tarpnell's ecological investigation in relation to the application of ecological methods to the study of native agriculture in Northern Rhodesia, which revealed that various native tribes have discovered the association of certain wild plants with certain soil types, and are able to fix on the location and decide on the nature of their cultivated crops in accordance with such observations. These findings would indicate that efforts to advance the prosperity of the country

should be directed towards building on the foundations already laid by the native himself, rather than to hazardous introductions or innovations. A session of the Conference was devoted to problems of fruit storage and transport, which have received considerable attention during recent years. The complex problems involved in this type of research are further complicated by the numerous factors which come into play, not only during the storage or fruit, but also while the crop is still on the tree. Various papers describing the work which is being done at Cambridge by the Food Investigation Board, in Canada, New Zealand, Australia and South Africa were read. Considerable interest was evinced in the paper on the storage of tropical fruits submitted by Dr. C. Wardlaw and Mr. R. Leonard and which is published in this issue. In the final session of the Conference attention was directed by Prof. E. E. Cheesman to the pressing need for greater facilities within the Empire for the collection and classification of crop varieties and related species. The work at present is seriously handicapped by the lack of adequate facilities.

The Sixth International Botanical Congress in Amsterdam was attended by about 900 members representing more than 50 countries. From the volume of abstracts of the sectional papers, which proved a useful handbook to the delegates, it is clear that a great variety of subjects of special and general interest were included. Opportunities were also given for joint discussions wherever subjects had an obvious dual interest. An admirable "History of Botany in the Netherlands" and a pamphlet on the Netherlands as an environment to plant life, had been prepared. Various excursions were arranged to botanical laboratories and gardens, the botanical garden in Leyden being a special attraction. Visits were also paid to Baarn, where the extensive collections of pure cultures of fungi was inspected, to the University of Utrecht, and to the Zuyder Zee, where the various processes by which areas submerged by the sea are converted into cultivatable polderland were seen.

The Fourth Imperial Entomological Conference was attended by 27 delegates, each representing a different dominion, Colony or other area of the British Empire. The papers read and discussed were: locusts and grasshoppers, by Dr. B. P. Uvarov; termites, by Mr. F. P. Jepson; cotton stainers and their control by Mr. W. Allan; sheep blowflies, by Dr. G. D. Marison; the biological control of insect pests, by Dr. W. R. Thompson; pests of stored products, by Prof. J. W. Munro; the need for forest entomologists, with special reference to the pinhole borer problem, by Dr. R. C. Fisher; and plant viruses and their insect vestors, by Dr. K. M. Smith.

Mr. Jepson's paper was of particular interest. Termites cause enormous damage, estimated at several millions of pounds sterling in the Empire alone, to crops, forest trees and all structures in which timber is employed in the tropics and sub-tropics. A very valuable account was given of various methods found effective to render buildings proof against invasion by subterranean as well as by drywood termites. Owing to the contamination of food by the faecal pellets of these insects, which occurs when they infest

roof-timbers, food-safes, &c., the varied protozoan and bacterial fauna of their intestines deserves further study. In Ceylon, it is usually in houses attacked by them that cases of sprue develop, and there is reason for suspecting that the contamination of human food by their solid excrement is in some manner associated with the causation of this disease. As a result of this paper the conference recommended the accumulation of data on the financial losses caused by termites to buildings, agriculture and the forest industry, the identity and habits of the species involved, and methods of control. Dr. Uvarov's paper on locusts described recent advances on a subject on which a large amount of coordinated study has been carried out for several years. As a result of an extensive international organisation of which the Imperial Institute of Entomology is the centre it has been possible to trace the movement and breeding of swarms over infested areas in Africa and south-western Asia, and to show that the recent outbreak of the tropical migratory locust, which spread gradually over the greater part of Africa, originated in one or two restricted areas on the Middle Niger, and that the red locust similarly originated in a few areas in Northern Rhodesia and Tanganyika Territory. Work on the desert locust has not progressed so far, but outbreak centres have been discovered on the coasts of the Sudan and of Baluchistan, and it is almost certain that none exists in the inner deserts of Africa. It will therefore be seen that the international investigations have provided a foundation for a preventive anti-locust policy, by which the outbreak centres can be kept under supervision and incipient outbreaks suppressed.

THE IMPORTANT INSECT PESTS OF THE CASTOR OIL PLANT IN S. INDIA WITH SUGGESTIONS FOR THEIR CONTROL*

AMONG the different oil seed crops cultivated in India, the castor plant (*Ricinus communis*) appears to be one of the most important and extensively grown ones. Recent statistics indicate that among the well-known castor growing areas of the world, such as Brazil, Russia, India and Egypt, India stands not only as the foremost grower but is also responsible for over 90 per cent. of the world's export trade in castor. Inside India though the crop is cultivated in small areas in parts of Berar, Baroda, Behar and the United Provinces, we find that the largest area under castor is to be found in Peninsular India including the Nizam's dominions, Mysore and the Madras Presidency: in fact, the area under this crop is greatest in the Nizam's dominions, the ceded districts and Mysore coming next in order. It is also well known that apart from its use as an oil seed producing plant, the castor plant is also utilised in many parts of India to feed the eri silk-worm—the rearing of which is becoming a popular and important cottage industry; in fact, the eri silk-worm is so named after its food plant (*Erandi* or *Eri*—castor). In view of such importance, it is up to South India to do everything in its power to hold its own superior position as the premier castor growing area in the world. One of the duties of the South Indian Castor grower, therefore, is to have sufficient knowledge of the insect pests, which cause serious damage to the growing crop, which often results in substantial loss to him.

It is the writer's idea in this paper to give the South Indian castor grower some general ideas of the more important insect enemies of that plant in this province with some suggestions in controlling them, so that they might be able to grow as far as possible a pest free crop.

Insects found on Castor.—Of the several insects which levy their seasonal toll on the castor crop in the different areas of this province the more important and the more numerous are those which feed on the foliage and the great majority of these are what are known as leaf eating caterpillars. Among the others which possess other habits such as boring into the plant tissue or sucking the plant juice, we have a shoot and capsule boring caterpillar, a stem boring beetle and some bugs including what are known as leaf hoppers, scale insects, stink bugs and mealy bugs. The important insects so far noted as more or less injurious to the castor plant can be grouped conveniently as below showing the general habits and the insect group to which each belongs.

TABLE OF CASTOR INSECTS

A. *Caterpillars.* (Biting insects).
1. Feeding exposed on the foliage.
   (*a*) Smooth caterpillars (both moths).
      i. Semilooper *Achoea janata*, L.
      ii. Ordinary *Prodenia litura*, F. (Known as the Tobacco caterpillar).

*By Dr, T. V. Ramakrishna Ayyar, B.A., Ph.D., Retired Government Entomologist in *The Madras Agricultural Journal*, Vol. XXIII, No. 12, December, 1935.

(*b*) Hairy caterpillars (all moths).
i. Uniformly hairy Black—*Pericallia ricini*, F.
Yellowish—*Diacrisia obliuqa*, W.
ii. Hairs with tussocks also Reddish—*Euproctis fraterna* M.
Greyish—*Olene mendosa*, H.
Yellowish brown—*Orgyia postica*, W.

(*c*) Case bearing caterpillar (moth). Bagworm—*Clania crameri*, W.

(*d*) Spiny or slug caterpillars. Spiny—*Ergolis merione*, Cr. (Butterfly). Sluglike—*Parasa lepida*, Cr. (Moth).

II. Boring caterpillar—The shoot and capsule borer—*Dichocrocis punctiferalis*, G. (moth).

B. Beetles. (Biting insects).
i. Leaf eating—flea beetle.—*Hermacophaga ruficollis*, L.
ii. Boring beetle—shot hole borer.—*Xyleborus fornicatus*, E.

C. Bugs. (Sap sucking insects).
1. Stink bugs.—The green plant bug.—*Nezara viridula*, L.
2. Leaf hoppers—the green jassid.—*Empoasca flavescens*, F.
3. Scales and mealy bugs—Black scale.—*Saissetia nigra* N.
4. Mealy wings—castor mealy wing.—*Trialeurodes ricini*, M.

Major and Minor Pests.—From the above it is evident that about twenty forms pay their attentions to the castor crop to a smaller or greater extent now and then. However, the castor grower need not be frightened at this fairly long list of insect guests, since it is generally found that neither do all these insects appear as regular pests season after season, nor does any one of them cause equally serious damage. Some of them are of minor importance and some others only appear rarely as sporadic pests while only a few are of real importance. The above list is given however to give the cultivator a general idea of castor insects to help him to make them out when they appear on the crop. The really serious or major pests of castor which appear more or less regularly and cause appreciable injury to the crop are caterpillasr including some of the leaf eating forms and the seed and shoot boring caterpillar.

Leaf-eating Caterpillars.—It is hardly necessary to state at the outset that these caterpillars are the young ones or larval stages either of moths or butterflies and these latter which are the adults do not cause any direct harm to the growing crop. Among the ten leaf-eating forms noted above under this category the semi looper *Achoea janata*, L. is the most important and is a specific pest of castor found very rarely on other cultivated plants. It enjoys a very wide distribution being found all over India. The adult insect is a stout built dark greyish brown moth with the fore-wing showing wavy brownish transverse lines and the hind wing having black and white patches. The full grown caterpillar which injures the foliage is about 2 to $2\frac{1}{2}$ inches in length, smooth and having a greyish dark brown colour (occasionally different shades of brown colouring are noted often with dark and brown markings also). Unlike the great majority of caterpillars which crawl about like worms, this insect is a semi looper the first pair of pro-legs becoming functionless. The insect starts its active life from young caterpillars hatching out of bluish green round beautifully sculptured eggs laid singly on the tender portions of the castor plant. Young caterpillars pass through the usual moults and in about two weeks assume the full grown condition described above. It is during this period that the damage is done to the foliage and this is often so serious that a whole plot is completely stripped of the foliage in the plants which are practically skeletonised. When fully fed the caterpillar changes into the pupa condition either under the soil or inside folds

of leaf on the plant itself and emerges as the adult moth in about another two weeks. The whole life cycle from egg laying to adult condition generally occupies about four weeks ; this period varies according to weather conditions in different localities. As stated above this insect is found very rarely and only in small numbers on other plants and these include the Rose, the Pomegranate and one or two species *Euphorbia*. All the leaf eating caterpillars of castor have more or less the same life histories with, of course, some differences, in the manner of egg laying, pupation and other minor characteristics. Next in importance to the castor semilooper comes the smooth cylindrical stout caterpillar. This insect, the adult of which is also a stout built brown moth, is a very common insect found in a number of other plants besides castor and is a specific pest of tobacco ; hence popularly known as the tobacco caterpillar. The eggs of this moth are laid in batches of many, each batch being hidden under a covering of felted hairs. The young caterpillars feed together gregariously during the earlier stages and separate gradually as they reach the full grown period ; at this latter stage the caterpillar is about an inch and a half in length, cylindrical and of a dark to blackish brown colour with yellowish and dark patches on the segments. The pupation takes place underground in an earthen case ; in a week or ten days the adult emerges from the pupa. The other caterpillars feeding on castor foliage are not of general occurrence, but occasionally appear as sporadic, and sometimes cause serious damage. The commonest of these are the different dairy larva of which the tussock caterpillars are the ones more frequently noted. These are all larvae of moths and among these the yellowish brown form (*Orgyia postica*, W.) now and then assumes destructive proportions. The other two tussock caterpillars and the hairy caterpillars are *Euproctis fraterna*, *Olene mendosa*, *Pericalla ricini* and *Diacrisia obliqua* having the same habits as *Orgyia* ; these are occasionally found in company at the same time. The last two are however very rarely seen in serious form. *Pericallia* is a more common pest of banana and lablab and *Diacrisia* is generally found on the hills and in North India as a general feeder. The bag worms which move about often enclosed in bags or cases made of thorns and sticks are not serious on castor in S. India. The slug caterpillar (*Parasa lepida*) which is apple green and covered with irritating spines and hairs is occasionally found as a pest on castor. The pupil cases of the creature are found as hard shell like objects attached to the plant stem. The spiny caterpillar (*Ergolis*) is the only one among these numerous caterpillars which is the larva of a butterfly instead of a moth ; the insect is a uniform snuff brown creature found flying about during day time unlike the moths.

Borers.—We now come to the borers which include (*a*) caterpillar (*Dichocrocis punctiferalis*, G.) which is in fact a somewhat important pest more or less with a status equal to the semilooper or the commoner leaf caterpillars and another (*b*) a small dark brown stem boring beetle (*Xyleborus*). The former is a short stout pinkish brown caterpillar with dark spots. It bores into the shoots especially at the junction of the main stem and the side shoots or leaves and in addition it also attacks the ripening fruits or seed capsules. The incidence of this insect on the plant is indicated by the presence of black excrementatious matter and webbing covering infested shoots and seed capsules. This boring caterpillar is often noted as a pest of Tumeric, Ginger and Cardamom also in different parts of S. India. The adult insect is a medium sized moth with yellow wings, spotted in dark.

Beetles.—Coming to beetles and bug pests of castor, most of them are of minor importance and are very rarely found as serious. The boring beetle (*Xyleborus fornicatus*, *E.*) is a small reddish brown creature found usually boring into the stem and producing numerous holes just as is found on bamboo and other posts in buildings throwing out powdery matter from the stem.

This was found serious on a species of the red variety of castor in Bangalore and has been recorded by the author in a previous paper with a plate. It is an insect found on Tea and other hill plants in Ceylon and South India. Tender leaves of castor are occasionally found attacked by a very small greenish flea beetle (*Hermacophaga ruficollis*, L.) ; numbers of this creature often bite small round holes on the leaves and thus injure the foliage. These are very active creatures and leap like fleas.

Bugs.—Among sucking insects found on castor the commonest is the mealy wing (*Trialeurodes ricini*, M.) which has a wide distribution all over India. It is a very small snow white winged moth like creature, often found in thousands on the under surface of castor leaves, especially on the foliage of fairly well grown plants. Hundreds of small yellowish seed like eggs are laid by this bug and from these emerge practically stationary larvae which are the real pests sucking the nutrition from the foliage. These larvae are more or less fixed to the leaves like scales, and in bad infestations the whole field appears pale ashy white and sickly and sticky to the touch due to the sweet secretion thrown out by thousands of these larvae. Scales and mealy bugs are rarely found and the species usually found among scales are the common black scale (*Saissetia nigra*, N.) the one generally found on various plants like cotton, coffee, guava, *Thespesia*, etc., and among the mealy bugs the common tomato and croton mealy bug (*Pseudococcus virgatus*, C.) is sometimes found. Both these are very rare and hardly cause any injury to the plants.

During the younger stages of the crop a small green leaf hopper (*Empoasca flavescens*, F.) almost similar to the one that attacks cotton, sometimes appear in swarms on the foliage, suck up the juice from the leaves and make them fade and curl up ; but very rarely is serious harm caused. From the above brief account we find that the only important insects the activities of which the castor grower in South India will do well to watch are a few of the leaf eating caterpillars and the borer caterpillar.

Control Measures.—As in the case of the most pests, both preventive and curative methods can be adopted in the case of castor pests also. For the leaf infesting caterpillars both preventive and curative measures can be adopted ; the former consists chiefly of cultural operations which will make the plants vigorous and keep away or withstand pest attacks, and the latter of mechanical and insecticidal operations. Among mechanical operations, the picking of egg masses and clipping off of and destruction of leaves containing numerous young caterpillars feeding together will be found very useful in the case of the tobacco caterpillar and the hairy larvae, all of which lay eggs in masses and the young caterpillars of which are gregarious in habits. In the case of the castor semilooper and frequently with the tobacco caterpillar prompt hand picking of the smooth caterpillar will be found effective and economical. When, however, the caterpillars are noted late at a time when they have already multiplied and increased in numbers and may not be amenable to any of the above measures, insecticidal methods can be used with advantage. The insecticides in this case where the creatures are all biting insects stomach insecticides (*viz.*, those which over the plant surface which when eaten will poison the insects) are to be used. These usually include arsenical preparations. Lead arsenate and Calcium arsenate are the ones which can be used either in the powder form or as a spray liquid mixed with water. In those localities, however, where water cannot be easily got, dusting the insecticide as a powder is certainly more effective and economic dusting should however be done where there are no strong winds in the fields or if the winds persist, then it is better to use the material as a spray. Dusting will be very effective if done early in the morning when there will be dew drops on the foliage which will make the poison dust stick to the leaf surface.

These insecticides and the necessary appliances such as duster and sprayers can be easily got from wholesale chemists or through the officers of the Agricultural Department.

For the shoot and capsule boring larva only preventive measures can be adopted since the creature feeds from inside and no external applications of insecticides will have any effect on it. The measures suggested are the prompt cutting off and burning of infested shoots and capsules and preventing their multiplications. The same is the case with the stem boring small beetle (*Xyleborus*). Very rarely do any of the sucking insects (bugs) found on castor call for any serious attention. If and when they do appear serious a spray with crude oil emulsion or tobacco decoction will check them easily. The mealy wing and any mealy bugs will also be easily controlled by such a spray. For the leaf hopper, when it becomes serious the waving of boards or winnows smeared with gum or some sticky material will trap hundreds of the hoppers and appreciably reduce their number on the crop.

In speaking of control measures it is possible that with some gradual observation and experience the cultivator can adopt in certain cases the method known as the biological control of pests ; this chiefly consists in the discovery of the enemies, especially insect enemies of the plant pest and artificially make use of them to destroy the pests. Different insect pests have different kinds of enemies and these have to be discovered and their habits and pest controlling capacity tried. In the case of castor caterpillars—the castor semilooper has been found subject to three or four parasitic insects which destroy it, very appreciably during certain seasons. The commonest of these parasites is a small dark braconid wasp (*Microplitis ophiusae*, R.). The presence of this parasite is easily found out by the peculiar position occupied by the parasite cocoon under the tail end of the dying semilooper caterpillar. Other wasps have also been noted recently on this and some on the castor boring caterpillar among the Ichneumonid and chalcid wasps. When the presence of such parasites is noted in the field it is better to collect these and keep them in wire gauze cage near the field so that the wasps which emerge can pass out through the meshes of the gauze cage while the moths if any from the cage cannot emerge through the small meshes of the gauze. The beneficial wasps will go into the fields and do their work on other caterpillars.

In conclusion it may be stated, that though the castor crop suffers less from insect pests compared to other crops like cotton, cholam or paddy, the damage it occasionally suffers from caterpillar plagues is often wholesale and very serious. The castor cultivator cannot therefore afford to ignore the insect pests of his crop and allow them to levy their heavy toll during certain seasons. A general knowledge of these pests will certainly be of advantage to him to save his crops from the clutches of insect pests and it is hoped this paper might help him to some extent in that direction.

INCREASED GROWING OF ETHIOPIAN COFFEE*

RECENT political events have directed world attention upon Ethiopia, the original home of coffee. From the viewpoint of this product, it is interesting to observe that, while coffee growing has spread to the four quarters of the globe, the wild coffee tree still grows in Ethiopia the same as it did centuries ago and its cherries are still being picked by the natives, many of whom make their sole livelihood from the sales of such staple. However, areas have of late years been planted with coffee and developments in quality have been brought about and new types have been added. While the total production is relatively not great, it has grown appreciably during the past decade and, due to its special merits, all offerings have found a ready world market. In view of the growing importance of Ethiopian coffees in the United States, your correspondent refers to the following report, prepared by U.S. Vice Consul William M. Cramp in Abyssinia.

COFFEE IN ETHIOPIA

The cultivation of coffee is said to have been begun in southern Arabia, the seed having been brought by Arab traders from the Kaffa district in Ethiopia. Coffee became known as "Mocha," taken from the name of the port which in former times was the leading port in the lower Arabian peninsula. For a long time the Arabian product monopolized the market, but with the gradual development of coffee plantations in the Lesser and Greater Antilles, Java, Brazil and other South and Central American countries, less than one per centum of the present world's supply is grown in Arabia and its environs. Less than one-tenth of one per centum originates in Ethiopia.

It was not until the beginning of the present century that coffee was cultivated in Ethiopia. Arabs from the Yemen, having noted the advantageous lands, favorable climate, soil, rains and altitude of the Harar plateau, brought the seeds and established small plantations there. Thus the seed, originally from Kaffa, returned to Ethiopia and a quality of coffee was produced which is generally considered almost as good as the Yemen varieties, by this time well known in the trade as "Mocha." There has been and is a small but constant demand for "Mocha" in the Near East for the making of the strong "Turkish" beverage and in the United States for the softening and aromatic effect obtained from blending with the South American coffees. Thus the Harar coffee generally finds a ready market.

Ethiopian coffees, known in the trade as "Abyssinians" and "Hararis," have always found a market abroad due to their close resemblance to the Yemen coffees. Cultivation has developed extremely solely due to concession difficulties, high internal export duties, high freight costs to the seaboard, etc.

*Extracted from the *Tea and Coffee Trade Journal*, Vol. 68, No. 6, June 1935.

Wild coffee, costing at source only the small wage for the collection of the beans, is with difficulty brought to the sea-coast or central market at prices comparable with those obtained for the cultivated product, although the coffee forests are vast and practically untouched. The failure of any considerable quantities of this coffee to reach the market is due to the feudal social organization in this country, involving heavy imposts by the lesser chieftains controlling the coffee lands, taxes collected by officials at each of the provincial customs stations, by the central Government's high export taxes, and by all and sundry who can collect anything in cash or kind from the coffee caravans. Also, the wild coffee forests are mostly found in dangerous wild animal country, and are far from the beaten trade routes.

ETHIOPIAN COFFEES

Twenty-five years ago natives in Jimma and Sidamo used coffee trees for fire-wood. They were told by European travellers of the value of the coffee berry in the markets and have gradually ceased burning the trees and now gather the berries for sale. For many years it has been a custom amongst the natives to boil the wild coffee bean and use it as a beverage and for ceremonial purposes.

The seed beds are thirty centimeters apart and are covered with grass to protect them from the sun. They are transplanted in ditches 50 centimeters across and carefully watered. Planting usually takes place at the beginning of the rainy season in June.

The trees bear in from two and one-half to three years and continue bearing for approximately fifteen years. They are then cut near the ground and begin a second bearing in about two years, which continues until the tree dies. It is then used for fuel. Replanting takes place near the former tree, but never at the root remnants.

Gathering is made a festive occasion, in which the entire countryside takes part and which is very similar to the old-fashioned harvest in the United States.

HARARI COFFEE

All coffee grown in the provinces of Harari and Tchercher is known in the trade as Mocha Harar Longberry. It is first quality coffee in Ethiopia, resembling Mocha of Arabia and the Central American and Colombian coffees. The berry, which is polished and bluish-green, is long and rather large, with an average of ten per cent. siftings. There is always a constant, if small, demand for this coffee in Egypt, Europe and the United States, as it is very mild and ideal for blending. Prior to 1925 the average annual crop was approximately 10,000,000 lbs., which has increased during the past few years to approximately 20,000,000 lbs.

ARUSSI COFFEE

In 1912 in the province of Arussi, two Belgian companies obtained the first foreign concession for coffee cultivation and began operating on a small scale. In 1916, all development was stopped by the civil wars then raging, and the projects were abandoned. However, in 1918 following the success

of His Majesty Tafarri Makonnen, the companies were indemnified for their losses, and work was resumed. They then merged into one company known as the Société des Plantations d'Abyssinie which is said to have a capitalization of 30,000,000 francs. Scientific and modern methods were introduced, roads built, and approximately 2,500 acres are now under cultivation. The coffee is of good quality similar to the Harari, but the bean is duller in color. It is known as Mocha of Arussi and is marketed in Europe, especially Antwerp and Le Havre. The average annual crop is about 1,000,000 lbs.

In spite of better grading, selecting, cleaning and packing, the company, which is at the present time the only foreign one operating in this country, has shown a deficit of over a million francs a year since 1929, when it is said a profit of fifty thousand francs was realized. As this annual loss cannot continue indefinitely, unless reductions are made in overhead, transportation costs and export duties and world prices increase, it is probable that the concession may be abandoned. The history of this company's concession has been that of all foreign attempts in scientific coffee cultivation in Ethiopia all of which have failed.

ABYSSINIAN COFFEE

Abyssinian coffees were unknown up to 1922, excepting small amounts that were exported to the Sudan *via* Gambela. Following improved price levels, the coffee from the wild growing forests of Jimma, Sidamo, Lekempte, and other provinces in the central and western part of the country, was brought to Addis Ababa, where it found a ready market. During the past several years tonnage exports of Abyssinian coffees have surpassed those of Hararis and have averaged 22,000,000 lbs. annually.

Under the trade name of " Abyssinians " fall several varieties of coffee, which take their names from the provinces in which they grow, as described hereunder :

(*a*) *Jimma Coffee.*—Coffee grown in the provinces of Jimma constitute more than half of the total crop known as " Abyssinians," and is taken as a basis for price quotations of the other coffees. The bean is uniform, medium size, round, fat and greenish-yellow, with an approximate average of fifteen per cent. siftings. There is very little ground smell. This coffee is known in the trade as Mocha Abyssinian Jimma, and may be compared with Superior Santos No. 4. At present, average annual production is about 10,000,000 lbs.

(*b*) *Sidamo Coffee.*—There are three types of Sidamo coffee, known as Tigre, Wattader and Sayir. The first two resemble Jimma coffee in quality, the berry being small and short, flat, uniform and greenish-yellow in color, with an average of ten to fifteen per cent. siftings. Sidamo Sayir is a poorer quality, the berry being darker in color with twenty per cent. siftings. All three are known in foreign markets as Mocha Abyssinian Sidamos and the average annual production is 5,000,000 lbs.

(*c*) *Lekempte Coffee.*—The coffee from this province has the same characteristics as Hararis, and having no unique taste blends easily and mixes

conveniently with other coffees. The berry is long and regular, yellowish-green, with siftings of some ten to twelve per cent. It is a good quality coffee, practically all of which is mixed with Harari coffee for export. The annual average production is 1,000,000 lbs.

(*d*) *Derani or Gore Coffee.*—This coffee resembles the Jimma and Lekempte coffees but has a larger and much darker berry, siftings are from ten to fifteen per cent. The annual crop is about 5,000,000 lbs. all of which grows wild and is exported *via* Gambela on the Nile.

(*e*) *Other Coffees.*—Small provinces within the major districts of Jimma and Sidamo give their names to coffees grown within their limits, *i.e.*, Goffa, Gumma, Guragi, Limo and Loumno. All of these coffees resemble Jimma, but have high sifting percentages (from fifteen to thirty per cent.) and have a strong earthy smell, which makes them undesirable for good blending.

COFFEE MARKETING

1. *Addis Ababa.*—The central market for Abyssinian coffees is in Addis Ababa. A small percentage of the coffees is brought to this market by European dealers having their own branches in the provinces, but probably ninety per cent. of the year's crop is brought by mule caravans under the direction of native *Nagadis* (merchants).

Caravans are usually large for protective purposes, and take about a month to get from the interior to the capital. Arrivals of the new crop begin about the end of December and continue until the beginning of June. The native merchant brings his caravan to the government customs house, the duties are paid, and only then sells the coffee to a local Arab broker. The European exporters then buy from the broker according to their needs and/or contracts to be met, paying cash for immediate delivery. The Arab broker gets a small fee, approximately 1 cent per farasula (37 lbs.) In general, the Addis Ababa branch of the larger exporting firms acts merely as a buying agent for the Djibouti office, which is the actual exporter. Close touch is kept between the two offices by telegram and letter, due to the daily fluctuations of existence stocks, new arrivals, local prices and rates of exchange.

The following figures indicate approximately the annual coffee crop in pounds of "Abyssinians" passing through this market: Jimma, 10,000,000 (50%); Sidamo, 5,000,000 (25%); Lekempte, 1,000,000 (5%); Goffa, 1,000,000 (5%); Gumma, 1,000,000 (5%); and all others, 2,000,000 (10%); making a total of 20,000,000.

2. *Arba.*—This is but a small railroad station on the direct line to Djibouti, but all coffee cultivated on the Arussi plantations is shipped at this point. Thus a small market has grown up with a custom-house at which export duties are paid.

3. *Dire-Daoua.*—All the coffee grown in the provinces of Harar, Tchercher and parts of Arussi are brought to the market in Dire-Daoua from whence they are shipped to Djibouti. Government warehouses exist at

Harar and at Dire-Daoua and all coffee must be brought directly to them, where a twenty per cent. tax in kind is collected by the Government before allowing the coffee to reach the hands of the exporter. The coffee is marketed by the Société Nationale d'Ethiopie a Government controlled import and export firm.

4. *Gore.*—The coffee crop which is gathered in the provinces of Kaffa and western Godjam is brought to the market at Gore where it is sold and duties are paid and is shipped *via* Gambela down the Blue Nile to Khartoum. There are no other major markets in the country, and it is interesting to note that quotations on Ethiopian coffees to foreign buyers are never made within Ethiopia, but always at Djibouti in the French Somali Coast.

TRANSPORTATION

As has been indicated, coffee is brought to the larger markets by mule caravan, where it is shipped *via* the Franco-Ethiopian Railway to Djibouti. The mule transportation cost is approximately one-third of the price of coffee obtained in Addis Ababa.

This includes the internal customs duties, but not the export tax. Railway freight costs are exceedingly high, amounting to approximately U. S. $30 per ton. The cost of a ton of coffee in Addis Ababa is augmented by approximately forty per cent. when placed on board a vessel in Djibouti, which is the quoted price to the buyer.

PACKING AND CLEANING

Excepting at the plant of the Arussi plantation, all coffee exported from Ethiopia, is packed and cleaned in Djibouti and prices are offered at the cost of hundred kilograms of cleaned coffee f.o.b. Djibouti.

Coffee cleaning is done by Somali women, who can clean two bags per day at a salary at approximately 10 cents American. The cleaning process is of the most primitive nature. Ethiopian women are unaccustomed to this work, and although cleaning has been attempted in Addis Ababa, it has nearly always failed. At the present time there is but one small cleaning plant in operation in Addis Ababa, the output of which is negligible.

Obviously, if the coffee could be cleaned here, freight costs would be less, due to the fifteen per cent. reduction in weight, expenses of unloading and reloading in Djibouti would be saved, and labour costs would be less as wages are lower in Addis Ababa than in Djibouti.

EXPORT TAXES

It is estimated that approximately 40 per cent. of the price of coffee, not counting railroad freight charges, is taken up in export taxes. The first tax collected is that levied by the chieftain under whose jurisdiction the coffee lands lie. This may be collected in cash or kind, and varies in amount depending on the strength and influence of each individual chief. The coffee then starts for Addis Ababa by caravan and pays as it progresses interior customs taxes, which are called Keret taxes and are generally paid in kind in each province it passes through.

The collection of these Keret taxes causes considerable delay at each provincial customs station and makes a considerable drain on the original quantities picked and shipped.

It is interesting to note that, in general, the export taxes are equal to the cost of the coffee at source plus the cost of transport.

Between 1909 and 1923, practically all the coffee exported from Ethiopia was grown on the Harar plateau. The average crop amounted to approximately 4,000 tons annually and coffee exports averaged 45 per cent. of total exports. Between 1924 and 1933 average annual coffee exports increased to 13,500 tons, about equally divided between Harar and Abyssinian coffees. These exports constituted an average of 57·8 per cent. of total exports in quantity and probably considerably more in value. During the past year 17,000 tons of coffee were exported by the Franco-Ethiopian Railway, which were 63 per cent. of the total quantity of all exports and 65 per cent. of the total value.

MEETINGS, CONFERENCES, ETC.

Minutes of the Meeting of the Board of the Tea Research Institute of Ceylon, held in the Ceylon Chamber of Commerce Rooms, Colombo, on Saturday, the 7th December, 1935, at 10·00 a.m.

Present.—Mr. James Forbes (Jun.), (Chairman), The Hon'ble the Financial Secretary (Mr. H. J. Huxham), The Acting Director of Agriculture (Dr. J. C. Hutson), Messrs. I. L. Cameron, R. P. Gaddum, J. D. Hoare, Col. T. G. Jayawardene, V.D., Messrs. D. H. Kotalawala, D. T. Richards, S. C. Bisset (Accountant), A. W. L. Turner (Secretary), and by invitation Dr. Roland V. Norris (Director, T.R.I.) and Mr. John A. Rogers (Superintendent, St. Coombs Estate).

Absent.—Major J. W. Oldfield, C.M.G., O.B.E., M.C., Messrs E. L. Fraser and A. H. Reid.

Notice calling the Meeting was read.

The Minutes of the Meeting of the Board of the Tea Research Institute of Ceylon held on the 9th November, 1935, were confirmed.

MEMBERS OF THE BOARD OF THE T.R.I.

Votes of thanks were recorded to Mr. C. E. Hawes and Mr. A. H. Reid for having acted on the Board during the absence of Messrs. I. L. Cameron and R. G. Coombe respectively. Mr. I. L. Cameron resumed his seat on the Board on the 15th November, 1935, and Mr. R. G. Coombe will be resuming his seat on the 10th December, 1935.

FINANCE

The Statement of Accounts as at 31st October, 1935, were adopted without comment, and the draft Estimates for 1936 were amended and adopted.

ANNUAL AUDIT

Messrs. Ford, Rhodes, Thornton & Company were re-elected Auditors for the ensuing year.

SENIOR SCIENTIFIC STAFF

Director, T.R.I.—Dr. Roland V. Norris—Announced that the Director who had been on sick leave resumed duties on the 2nd December, relieving Dr. C. H. Gadd who was acting for him.

The Board expressed their thanks to Dr. Gadd for the extra work he had done.

JUNIOR SCIENTIFIC STAFF

Research Assistant, Agricultural Chemistry—Dr. J. G. Shrikhande. Announced that this officer should have reported for duty on the 1st December, but had been unable to do so owing to an attack of Appendicitis. He was expected to report for duty in January.

JUNIOR STAFF MEDICAL SCHEME

The Chairman said that on the 31st December, 1935, this Scheme would complete its first year and as the Board had formally decided that it should be run for one year as an experiment it was necessary to reconsider the matter.

The Director supported the Chairman in his statement that there had been no difficulty in running the Scheme and that it would be in the interests of all concerned if it were put on a permanent basis.

The Board decided that the Medical Sub-Committee should draw up rules to establish the Scheme on a permanent footing. The present Medical Sub-Committee consists of :—The Chairman, T. R. I., The Director, T.R.I., and Major J. W. Oldfield, C.M.G., O.B.E., M.C.

INDIAN TEA ASSOCIATION

Chief Scientific Officer's Report on his visit to Java.—The Chairman announced that copies of this Report had been ordered for the members of the Board and the library at St. Coombs.

Mr. Gaddum said that the General Committee of the Planters' Association of Ceylon had asked him to ascertain if the Indian Report could be published in the "Tea Quarterly."

It was decided that the Director should approach the Indian Tea Association and ask for permission to carry out the Planters' Association's suggestion.

Small Holders.—A suggested design of the certificates to be issued to Prize winning Small holders was handed round the Board and approved.

The Chairman expressed regret that neither he nor the Director had been able to attend the recent Prize Giving owing to illness ; Dr. Gadd had attended and reported that the Prize Giving was a great success.

The Board recorded a vote of thanks to those concerned in making the arrangements.

Java Parasites.—It was decided that the following Memorandum written by Mr. C. B. R. King, Entomologist, should be incorporated in the Minutes.

TORTRIX PARASITES FROM JAVA

Object of Importation

It has been known for many years that although the Tea Tortrix exists in Java, it is not accounted a serious pest there. I have already drawn attention to the desirablity of investigating the question of Java parasites, especially in the "Tea Quarterly," Volume VI, page 173, since the mild activity of Tortrix in Java pointed either to the effects of a different climate or to parasitic control. The former, as far as one could tell, appeared far more unlikely than the latter. I had already had correspondence with Java on the subject in 1932, but unfortunately it came to nothing. Personal contact in 1935, however, had made all the difference, and the present shipment is the result of the discussions of the Director in Java on some notes prepared by myself. Of the present lot, there are two species not so far known in Ceylon ; and of one at least, I have great hopes—but it would perhaps, be safer not to be too sanguine in advance.

C. B. REDMAN KING,
Entomologist.

On the Chairman's suggestion it was decided to record a vote of thanks to the Director of the Institute of Plant Diseases, Buitenzorg, for the trouble and care taken in despatching parasites for the use of the Institute in its Anti-Tortrix campaign.

Secretary, T.R.I.—The Chairman announced that Mr. A. W. L. Turner had resumed duties as Secretary of the Board on the 20th November, 1935.

A vote of thanks to Mr. S. C. Bisset for having acted during Mr. Turner's absence was recorded.

A. W. L. TURNER,
Secretary.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 31st JANUARY, 1936

Province, &c.	Disease	No. of Cases up to date since Jan. 1st, 1936	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	Nil.	..	..	..	..	..
	Foot-and-mouth disease	Nil.	..	..	..	..	..
	Anthrax	Nil.	..	..	..	..	..
	Rabies (Dogs)	5	5	..	..	..	5
Colombo Municipality	Rinderpest	Nil.	..	..	..	..	..
	Foot-and-mouth disease	Nil.	..	..	..	..	..
	Anthrax	Nil.	..	..	..	..	..
	Rabies	6	6	..	6	..	..
Cattle Quarantine Station	Rinderpest	Nil.	..	..	..	..	..
	Foot-and-mouth disease	Nil.	..	..	..	..	..
	Anthrax	2	2	..	2	..	..
Central	Rinderpest	Nil.	..	..	..	..	..
	Foot-and-mouth disease	180	180	78	..	102	..
	Anthrax	Nil.	..	..	..	..	..
Southern	Rinderpest Foot-and-mouth disease Anthrax	FREE					
Northern	Rinderpest Foot-and-mouth disease Anthrax	FREE					
Eastern	Rinderpest Foot-and-mouth disease Anthrax	FREE					
North-Western	Rinderpest	Nil.	..	..	..	..	..
	Foot-and-mouth disease	56	56	25	..	31	..
	Anthrax	Nil.	..	..	..	..	..
	Rabies (Dogs)	4	4	..	..	..	4
North-Central	Rinderpest	Nil.	..	..	..	..	..
	Foot-and-mouth disease	464	464	287	..	177	..
	Anthrax	..	..	..	..	..	..
Uva	Rinderpest	Nil.	..	..	..	..	..
	Foot-and-mouth disease	Nil.	..	..	..	..	..
	Anthrax	Nil.	..	..	..	..	..
	Rabies (Dogs)	2	2	..	1	..	1
Sabaragamuwa	Rinderpest Foot-and-mouth disease Anthrax	FREE					

Government Veterinary Department,
Peradeniya, 12th February, 1936.

M. CRAWFORD,
Government Veterinary Surgeon.

METEOROLOGICAL REPORT—JANUARY, 1936

Station	Temperature				Humidity		Amount of Cloud	Rainfall		
	Mean Maximum	Difference from Average	Mean Minimum	Difference from Average	Day	Night (from Minimum)		Amount	No. of Rainy Days	Difference from Average
	°	°	°	°	%	%		Ins.		Ins.
Colombo ..	85·4	−0·9	71·1	−0·9	67	88	5·6	2·52	3	− 1·51
Puttalam ..	84·9	−0·5	68·9	−1·3	76	95	4·2	1·18	6	− 2·40
Mannar ..	83·7	−0·2	73·8	−0·4	74	86	3·8	1·60	6	− 2·36
Jaffna ..	84·1	+1·4	71·6	−0·6	68	90	3·6	0·02	2	− 4·32
Trincomalee ..	81·1	+0·7	74·9	−0·1	75	78	6·0	5·81	10	− 2·89
Batticaloa ..	81·1	−0·3	72·0	−1·7	79	93	5·7	12·64	12	− 1·13
Hambantota ..	83·8	−0·8	71·5	−1·3	78	90	4·0	4·20	10	+ 0·50
Galle ..	82·9	−1·3	72·7	−0·1	78	90	4·9	2·25	10	− 0·39
Ratnapura ..	87·0	−2·0	70·5	−0·7	70	95	4·8	3·20	12	− 3·27
Anuradhapura ..	82·9	+0·3	68·2	−1·3	74	95	6·0	2·46	8	− 3·25
Kurunegala ..	85·9	−0·2	68·1	−2·0	66	90	4·4	3·09	6	− 1·78
Kandy ..	83·1	+0·8	66·4	−1·0	66	84	4·8	3·93	10	− 2·73
Badulla ..	75·9	−0·1	61·6	−2·2	78	94	5·5	6·82	12	− 3·73
Diyatalawa ..	71·6	+0·1	55·7	−2·1	71	88	4·8	4·58	12	− 1·76
Hakgala ..	67·6	+2·5	49·0	−4·3	72	87	5·8	7·46	13	− 4·67
Nuwara Eliya ..	68·1	+1·0	43·6	−3·7	64	89	5·9	4·17	10	− 2·57

The rainfall of January was below normal over practically the whole Island. The only appreciable area showing excess was the coastal strip between Yala and Matara, but the excess there was only slight. Deficits were greatest in the low-country areas immediately to the north and north-east of the hills, where they ranged between 5 and 10 inches, and at several stations in the eastern half of the hill-country, most of which reported deficits of the same magnitude. The highest totals for the month were 27·35 inches at St. Martin's, and 25·94 inches at Hendon. These stations, whose January average is exceptionally high, also reported the greatest deficits, 15·4 inches at Hendon and 13·4 inches at St. Martin's.

There were 34 daily rainfalls of 5 inches or over reported, nearly all on the 12th. The highest falls were 11·20 inches at Illuktenna, and 10·00 inches at Meeriatenna, both on the 12th.

The dry spell which set in towards the end of December lasted till the 5th of January, with the usual low night temperatures. The minimum temperature at Nuwara Eliya reached 29·0° F. on the night of the 4th to 5th, the lowest air temperature recorded there for nearly seven years. For the next few days there was slight or moderate rain, mainly in the east of the Island. On the 11th the rainfall increased, particularly in the north. The barometer then fell, the gradient steepened, and weather conditions became distinctly unsettled. On the 12th there was widespread rain, particularly heavy on or near the eastern slopes of the hills. The rain continued widespread, and heavy in places, for the next two days, with irregular barometric gradients. On the 15th another dry spell set in, with low minimum temperatures, but only lasted till the 19th, when the rainfall again increased. For the next few days the rain was widespread, and fairly heavy in places, particularly near the hills, but after the 23rd it was mainly reported from the south-west, as the result of local thunderstorms. On the 26th another dry spell set in, lasting till the 30th, when the rainfall increased slightly.

Day temperatures in general showed no marked deviations from normal, while night temperatures were everywhere below normal, particularly up-country. Humidities and cloud were also generally below normal, particularly up-country. Barometric pressures were a little above normal, while wind strength was on the whole about normal. Wind directions were generally N.E. or N.

H. JAMESON,
Supdt., Observatory.